selca

CNC - SERIES S3000

Machine Logic
Development Manual
(PLC)

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REVISIONS (cont.)

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INTRODUCTION

INTRODUCTION

This manual is intended for the (OEM) of machine tools and machining centers who wish to install the SELCA series S3000 numerical controller.
This manual provides all of the information on the MACHINE LOGIC operated by the PLC integral to the Series S3000.

The manual provides a description of the instructions used in programming the PLC, as well as describing the system interface and the interchangeable commands. Also provided are complete examples of real applications, form which ideas may be taken for writing custom applications.

When required, the manual calls out the differences between the Series S3000 system and the preceding system (S1200). This information may be helpful for those who have been working with the earlier system.

REFERENCES

In addition to this manual please refer to the following documents for further information on the S3000 system hardware and NC programming.

- User's Manual (for Programming)
- System Configuration Manual
- Installation Manual

SUMMARY

The manual is divided into three independent parts:

Part I Programming language and operating procedures
This part contains descriptions of all the programming instructions, including simple examples, as well as utilization procedures and the softkeys that control the operations in this area.

Part II System Interface
This part describes all of the instructions exchanged by the PLC and the NC, including their function and use.

Part III Programming examples
This part contains a few examples of actual applications which were made using the PLC language.The contents of the individual chapters found in each of the parts is as follows:

Part I

Chapter 1 Characteristics and Usefulness
This chapter lists all of the primary characteristics of the SELCA Series S3000 and their usefulness.

Chapter 2 Operating procedures
This chapter describes the softkeys used in the APPLICATIONS environment to execute such programming operations as; editing, compiling, activating, and debugging.

Chapter 3 Program organization
This chapter describes the program structure as well as the format for constants and variables used within the program.

Chapter 4 Pre-settings
This chapter contains a list of variables which must be set prior to beginning programming. For example; inputs/outputs, impulse types, counters, logic definable softkeys, internal variables and timers.

Chapter 5 Functions and Operations
This chapter describes the instructions used during the programming, including related parameters and limits. The functions are subdivided into: logic, format variables conversion, arithmetical/mathematical and string operations.

Chapter 6 Instructions for program controls
This chapter describes the functions which vary the program flux while it is running; such as, jumps, loops, and subroutines.

Chapter 7 Special Functions
In the final chapter of Part I certain user functions are described such as; statistical calculations, signal selection, and user messages.

Part II

Chapter 1

This chapter contains descriptions of the registers, PLC/NC interface variables, including each variable's characteristics and format. The registers are grouped by type or function.

Chapter 2

This chapter describes the functions of the registers described in the previous chapter, that is it describes the control of the mandrels, axis movements, and tool changer control.

Chapter 3

This chapter briefly describes the modifications needed to convert a series S1200 program to an S3000 program.

Chapter 4

This chapter contains a table which summarizes the registers and associated variables described in chapters 1 & 2. This table is particularly useful as a reference sheet for programming.

Part III

The third part contains a single chapter which lists various program examples which may be used on their own, or as starting points for writing programs to perform analogous work.

TERMINOLOGY AND SYMBOLS

All of the instructions and variables defined previously are capitalized and written in boldface (ex. **VARIAB**), while those written in boldface and lowercase are references for generic instructions or expressions which are to be assigned by the program (ex. **operator**).

In the instruction syntax all that is contained within these symbols **[**and**]**, is optional and may even be omitted.

The symbol **|** is used to separate choices in parameters; (for example **A|B|C** means either A, or B, or C may be inserted.)

The keys of the keyboard are represented as they appear on the NC keyboard (except for the alphanumeric keys). (es. ↑, Ctrl, F10, Menu 0, ecc.).

Note: The Return key is positioned vertically on the keypad (Retur n). However it is represented horizontally in this manual for better use of space Return .

The term "set" indicates the forcing of a variable to the logic level "1" or "true".

The term "reset" indicates the forcing of a variable to the logic level "0" or "false".

S1200 T This symbol indicates the description of differences between the series S12000 and S3000 systems. This will be particularly useful for those who have already installed or have been using the S1200 system.

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PART I

PROGRAMMING LANGUAGE AND OPERATING PROCEDURE

1. USES AND FUNCTIONS

The Series S3000 offers a selection of controls to satisfy the growing use of machine tools and factory automation in general.

The CNC S3045 is particularly useful for milling machines for tool makers and mold and die shops, machining centers with multiple axes, accurate machining at high speeds and for complex surface work.

The CNC S3040 supplies an integrated solution which is compact and cost effective for work cells, and machining centers for production mill work and automated assembly stations for flexible high volume production.

The CNC S3024 systems are designed for lathes, turning centers and a large number of multi-axis work cells with slow cycles.

1.1. MAIN CHARACTERISTICS OF THE SERIES S3000

The following describes some of the characteristics and uses of the Series S3000 controls. Considering the limited space and scope of this manual. Not all of the characteristics of each model are described, only some of the more significant ones. For more detailed information please refer to the technical Specifications for the particular model in question.

In the fully configured higher level systems the main features are as follows:

- Advanced 2-D and 3-D conversational programming with interactive graphics and integrated PROGET2 language.
- Control of up to 16 axes, including 4 spindles.
- Control of 8 axes simultaneously.
- Utilizes all types of transducers (rotary and linear incremental encoders, fiber optics, absolute and cyclical resolvers).
- Up to 8 independent PLC programs for controlling groups of auxiliary axes.
- Standard execution speed over 300 blocks per second, increased to 1000 blocks per second in the P (Plus) version.
- Integral PLC with high level language including a graphic and numeric analyzer.

- Digital I/O: 32 inputs and 24 outputs, expandable to 384 inputs and 288 outputs.
- Analog I/O: 24 outputs and 41 inputs, plus 8 inputs for temperature probes.
- Tool Center Point Management function TCPM, for 5 axis machines with automatic control of tool to work piece contact in three dimensions, with bi-rotational heads and rotating or tilting tables. (Version P)
- Cubic interpolation for high speed work of complex shapes (Version P)
- Three dimensional surface scanning for digitizing and direct copying
- Mass storage (DOS compatible hard disk, and floppy disk)
- Interface and communication software for serial and network communication (point to point and multi-point).
- Expandable configuration (L and PL) allowing additional I/O and transducer and hard disk interfaces as well as network connections.
- Compatibility with earlier SELCA CNC models.

2. PROCEDURE

Before examining the program structure and writing instructions, it is helpful to understand the operating procedures for the PLC machine logic programs. The procedures for the peripherals not described herein may be found in the User's Manual for Programming.

Programs can only be run and debugged if +24V is present on the I/OMIX PC board and all of its expansion cards (see Installation Manual). This is not a requirement for editing or compiling programs.

The PLC programming environment, as well as the machine parameter configuration environment (APPLICATION) are not normally accessible to the user. To obtain access to this environment it is necessary to follow the procedure below:

1. Press the Menu 0 key
2. Press the Esc key

   The following softkey menu appears.

NC OPERATIONS	LOGIC MESSAGES	PART PROGRAMS	PERIPHER	MONITOR SETUP	UTILITIES TOOLS	DIAGN TOOLS

3. To access the APPLICATIONS environment for the first time after turning ON the NC, press the keys Shift + F2 simultaneously.

The softkey LOGIC MESSAGES changes to LOGIC SYS/SETUP and remains that way until the NC is turned OFF. The softkey menu then appears as follows. The LOGIC SYS/SETUP softkey allows access to the machine logic described in this manual. For subsequent access it suffices to press the (F2) key or LOGIC SYS/SETUP softkey F2.

NC OPERATION	LOGIC SYS/SETUP	PART PROGRAMS	PERIPHER	MONITOR SETUP	UTILITIES TOOLS	DIAGN TOOLS

The are two modes of operation for PLC program maintenance:

EDIT LOGIC - to write or modify an existing program

DEBUG LOGIC - to verify the the PLC program function, the integrity of the inputs and outputs and the correct functioning of the algorithms.

2.1. EDITING THE LOGIC

The procedures selected from this menu allow the writing of PLC programs directly on the machine using all of the instructions and commands explained in this manual.

To write a new program it is necessary to respond to the system prompt with an alphanumeric name with a maximum of 8 characters in capitol letters. The first character must not be a number. Then press Return.

If the program has already been stored in memory it will appear on the display otherwise a new one will be created under the name given.

The menu functions allow the insertion and modification of text the movement and cancellation of large blocks of text, copying text from other programs, substitution of words and automatic line numbering.

The keys for moving the cursor are:

↑ to move up one line
↓ to move down one line
Home to move to first line in the program
End to move to the last line in the program
PgDn to move one page down
PgUp to move one page up

To move the cursor along a line:

→ to move to right of a character
← to move to left of a character
Ctrl + Home to move to the beginning of a line
Ctrl + End to move to the end of a line

All of the operator or machine dialog operations are effected by softkey and if necessary an associated request line for parameters. These are organized within menus and are accessed by activating the relevant softkey. The following keys are reserved to speed-up this process:

Esc returns to the previous menu
Menu 0 returns to the main menu

The written program is saved automatically each time the Return key is pressed or when the editor is exited by Esc or Menu 0.

The functions used for writing, editing, and modifying PLC programs are reviewed below. For more details please consult the *User and Programmers Manual*.

Edit Menu

To access the edit menu perform the following steps:

1. From the APPLICATIONS environment menu shown previously press the softkey LOGIC SYS/SETUP to access the main applications menu shown below:

LOGIC EDIT	LOGIC DEBUG	SYSTEM SETUP	SYS SETUP FILES	SCREEN CONFIG	FEEDBACK ERR COMP	COM PROG EDIT	PERIPHER	FLASH MEMORY	BACKUP / RESTORE

The softkey present in this menu, with the exception of the first two, are described in the *System Configuration Manual*, which should be used for reference.

2. Press the ***LOGIC EDIT.*** Softkey to access the following menu:

MEMORY	FLOPPY DRIVE	FLASH MEMORY	EDIT PLC LOGIC	COMPILE PLC LOGIC	COMPRESS COMP OUT	LOAD AND RUN PLC	RENAME PROGRAM	COPY PROGRAM	DELETE PROGRAM

The first three function keys (F1, F2, F3) and the last three (F8, F9 and F10) control the same functions as the equivalent softkeys in the NC programming environment. For details refer to the *User and Programmer's Manual*.

Other softkeys function as follows:

LOGIC EDIT Activates the logic editing environment from which it is possible to write and maintain a PLC program.

COMPILE LOGIC Compiles into executable instructions those programs created or modified using logic edit.

COMPRESS COMP OUT Running the LOGIC COMPILER with this function enabled (default) will obtain a shorter executable file than if it were compiled uncompressed. In the compressed mode the compiling function takes longer.

Note: Compiling compressed programs requires more active memory space than normal compiling, therefore memory shortage problems may arise when particularly long programs are compiled on systems with limited memory.

Edit Logic Menu

When the EDIT LOGIC softkey is pressed a list of all the present logic programs is displayed in the center of the screen. One of these may be selected by moving the cursor over the desired program useing the ↑ or ↓. arrow keys. The name of the chosen program will also appear in the command line. If a new program is desired, it is necessary to write the program name over the one present in the command line.

After selecting or writing in a name, press the softkey ***EDIT LOGIC*** (F4) or Return. A new menu will appear along with a listing of the program if already existing. A new program may be written directly using the keyboard. To modify or delete program blocks while editing, the following softkeys should be used:

INSERT BLOCK	MODIFY BLOCK	DELETE BLOCK	STRING SEARCH	ADVANCED EDITING

The function of each softkey for PLC programming is as follows:

INSERT BLOCK To insert a new program line, position the cursor on the block which comes directly after the one which needs inserted (the INSERT BLOCK function is active as soon as you enter this menu); write the new block then press Return .

MODIFY BLOCK Press this key to modify the line the cursor is currently positioned on. Modify the block as it is presented within the command line box, then press Return .

DELETE BLOCK Press this key to delete the line on which the cursor is currently positioned. A confirmation message is delivered:

Do you want to delete? (YES/NO)? Yes

Press Return .

STRING SEARCH This key starts the search for a string of characters within the program starting from the cursor position. If a number is specified the cursor is moved directly to that line in the program. Both the character string and line number must be followed by a Return .

ADVANCED FUNCTIONS This key activates a menu for block operations such as text copy and editing parameters. To use all of the softkeys from this menu sufficient memory area is needed. In the cases where available memory is limited the available functions are limited to two.

Advanced function menu

When the ADVANCED FUNCTION softkey is selected and sufficient memory space is available, the following menu will appear:

HIGHLIGHT BLOCK	DELETE BLOCK	COPY BLOCK	MOVE BLOCK	DELETE FROM HERE	REPLACE STRING	IMPORT FROM OTHER	RENUMBER BLOCKS	EDITING PARAMS	CANCEL MODIF

In the case where there is insufficient memory only the following two softkeys appear:

DELETE FROM HERE	REPLACE STRING

HIGHLIGHT BLOCKS This key is used to highlight a block or group of blocks to be worked on. To highlight the blocks move the cursor to the first block to be selected use ↑ or ↓) keys press the softkey ***HIGHLIGHT BLOCK***, position the cursor on the last block to be selected and press the same key.

DELETE BLOCKS Will delete the highlighted blocks confirm with Return.

COPY BLOCKS Copy blocks previously highlighted to another area in the program. Move to the desired position for the block using the ↑ or ↓ keys, press Return to confirm. The block will be inserted on line just below the cursor position.

MOVE BLOCKS Move blocks previously highlighted to another area in the program. Move to the desired position for the block using the ↑ or ↓ keys, then press Return. The block will be inserted on line just below the cursor position.

DELETE FROM HERE Deletes all lines to the end of the program, starting with the line on which the cursor is presently positioned on. The following message appears:

Delete all sucessive blocks? (YES/NO)? YES

Press Return to confirm.

CHANGE STRING Substitutes one string of characters for another by searching for the desired string starting from the cursor position. The following message will appear:

Replace (string 1/string 2):

Write in the new string to be substituted, and confirm with Return.

COPY FROM OTHER Insert a block copied from another program into the present program proceed as follows:

- Press the **IMPORT FROM OTHER** softkey for a list of programs in memory.
- Select the program which contains the block to be extracted and press Return
- Highlight the block to be copied then press Esc twice to return to the program which is to receive the block.
- Position the cursor at the point where the block is to be inserted and press the softkey **COPY BLOCK**.

RENUMBER BLOCKS Renumbers the program lines according to the edit parameters (increment, number of spaces...). Automatic line numbering occurs only if lnew lines are added to the end of the program.

EDIT PARAMETERS Changes the line numbering parameters. Activates a new softkey menu from which the parameters may be adjusted.

DELETE MODIFIC. Deletes the last changes made using the advanced function keys (this can only be accomplished from the **ADVANCED FUNCTIONS** menu).

Edit parameters menu

When the ***EDITING PARAMS*** softkey is pressed the following menu appears:

BLOCK # FORMAT	BLOCK START #	BLOCK # INCREMENT	RENUMBER BLOCKS	TRANSLATE FROM 1200

CHANGE SPACES This softkey controls the spacing before each block for the sequence number. The valid numbers are between 3 and 8. Press Return when completed.

CHANGE FIRST This softkey sets the first sequence number, or first block. Valid numbers are between 1 and 10. Press Return when completed.

CHANGE STEP This key adjusts the spacing between individual blocks and between blocks and their sequence number. Valid numbers are between 1 and 10. Press Return to confirm.

RENUMBER BLOCKS To apply the new parameters press this key followed by Esc. You will then return to the previous menu.

TRANSLATE PLC 1200 The system S1200 programs differ slightly from the Series S3000 to make them completely compatible press this softkey while editing the older programs.

2.2. COMPILE LOGIC

This is the first operation to be performed after creating a new program or modifying an old one to verify correct syntax, and to render it executable by the computer. During the execution of this command the system displays the line number being compiled any errors will stop the program. An error message will be displayed together with the program line number in which the error was found. If the compiling operation is successful the following message will appear:

Program compile end: "program name".

If an error is found during compiling, the software will automatically return to the edit mode and place the cursor at the line where the error was found.

2.3. LOAD AND RUN

The ***LOAD AND RUN*** softkey accessible from the ***EDIT LOGIC*** menu, resets the PLC variables memory and starts the execution of the last PLC program to be compiled. The key is illuminated when a PLC program is being executed.

It is possible to halt the program by pressing the same key.

The PLC may be de-activated automatically in the following cases:

- Hardware errors such as losing 24V on the main board, or high current draw on the outputs, etc..
- Grave software errors such as CALL and RTS out of sequence long fast and superfast calculations and floating point errors (overflow, underflow, etc.). In these cases an error message appears which describes the type of fault which halted the program.
- Changes in the base configuration of the machining center such as number of axes, etc.

The ***DEBUG LOGIC*** menu contains the softkey ***ENABLE LOGIC*** which performs the same function as ***LOAD AND RUN*** except it does not reset the memory.

2.4. TRANSLATION OF PROGRAMS EDITED ON S1200

The series S3000 systems adopt the following PLC program line numbering syntax:

Nxx instruction

in the earlier Selca systems the syntax was:

xx instruction

To automatically convert the old numbering system to the new it is necessary to:

- edit the program to be converted
- Press the following softkeys in order: ***AVANCED FUNCTIONS, EDIT PARAMETERS, TRANSLATE PLC 1200.***

This will overwrite the old program.

2.5. LOGIC DEBUG

The debug environment is reached by pressing the ***LOGIC DEBUG*** softkey from the main applications menu. The following menu will appear:

ENABLE PLC LOGIC	DYNAMIC DISPLAY	GRAPHIC ANALYZER	PLC LOGIC MESSAGES	CROSS REFERENCE	SCREEN TABLES	ANALYZER FILES		FORCING FILES	RESET SRAM

In this environment all system diagnostic signals and variables may be displayed and run. These tools are not just used during the set-up of the machine, but may be used over the entire life of the machine.

It is also possible when for debugging to store in tables all display variable settings, so that the system may be checked out in cases of malfunctions or service and repairs.

The functions available in this environment are described in the following sections.

2.5.1. DYNAMIC DISPLAY

This function displays the current numerical value of signals or variables.

The softkey menu is as follows:

ENABLE DISPLAY	INSERT NAME/EXPR	MODIFY NAME/EXPR	DELETE NAME/EXPR	DISPLAY INPUT	DISPLAY OUTPUT	FORCED ASSIGN.	..MORE..

The function of each of the softkeys is as follows:

ENABLE DISPLAY *Allows* the freezing of variables which are changing rapidly so that they may be more easily read. These values remain on the display until the key is pressed again (however the variable continues to beupdated within the system). The key is active when this menu is entered; if it becomes deactivated it signifies that the variables are frozen.

INSERT NAME/EXP. The variable name to be displayed must be typed after this softkey is pressed; press Return to confirm.

To insert more names on the same line place the ";" symbol between each name.

MODIFY NAME/EXP. After selecting a variable using the ↑ or ↓, keys press this softkey to modify the selected variable. Press Return to confirm.

DELETE NAME/EXP. Deletes the variable on which the cursor is positioned.

DISPLAY INPUT
DISPLAY OUTPUT This key allows the verification of the binary status of the input and output bytes on the I/O MIX card. The display will present a variable IN_001(n); where (n) is a binary number. The 8 bits represent the states of the 8 relative input/output bytes starting from right to left.
In screen, the PgUp and PgDn keysare used to view the similar signals from the other I/OMIX cards and are identified by the variables IN_00x(n).

FORCED ASSIGNMENT This function may be used to force a value on a variable and measure its effect immediately (see a description of forced values further ahead).

ADVANCED FUNCTIONS Activates a new menu with more commands.

By pressing the ***..MORE..*** softkey the following menu appears:

DECIMAL BINARY	SEARCH ASSIGN.	EXPAND EQUATION		CLEAR ALL		SAVE TABLE

DECIMAL/BINARY Changes the display format from decimal to binary and vice versa for the variable selected by the cursor.

SEARCH ASSIGN. By supplying the name of a variable used in the active PLC program, all of its assigned values are searched. Related equations are displayed dynamically.

EXPAND EQUATION Permits equations to be expanded so that all of the terms in the equation selected by the cursor are displayed separately. Usually this function is used after the ***SEARCH ASSIGN***. softkey is pressed.

CLEAR ALL Erases all of the names and expressions present in the dynamic display.

SAVE TABLE Stores all of the names and expressions displayed so that they may be recalled later by RECALL TABLE. It is necessary to supply the name of the table to be stored, then press Return.

2.5.2. GRAPHIC ANALYZER

The system is designed to display a graphic signal of movement with respect to time of 16 signals in bit format(such as; inputs, outputs, internal variables) and 4 numerical variables (in non-bit format). The signals and numeric variables are displayed simultaneously using different colors to distinguish them even when they may be overlapping. The trace is formed by conditioning the stored signal by use of a trigger function.

If a variable is to be traced in a pre-established field not in bit format it will be necessary to specify it using the following syntax:

nomevar[,min, max]

If the limits are not specified an "autoscaling" mechanism will allow the display of the variable in the center of the screen. This mechanism may not be satisfactory when the signal is changing at high frequency (for example, electrical noise on a small signal).

To insert more names at the same time insert the character ";" between each name.

Setting-up the graphic analyzer

To set the graphic analyzer parameters the softkey ***GRAFIC ANALYZER*** is pressed from the ***DEBUG*** menu:

ACQUIRE	ENTER NAME/EXPR.	MODIFY NAME/EXPR.	DELETE NAME/EXPR.	TIME BASE	ACQUIRE TIME	FORCE ASSIGN.	TRIGGER NAME/EXPR	TRIGGER TIMING	..MORE..

The function of each key is as follows:

ENTER NAME/EXPR. After pressing this key the variable name to be displayed is typed and then the Return key is pressed to confirm.

MODIFY NAME/EXPR. After having selected a variable this softkey will allow for the name to be changed to that of another variable, as well as for allowing the max/min limits to be changed. When finished press Return.

DELETE NAME/EXP. Removes the variable on which the cursor is resting form the display.

TIME BASES Selects the interval between two consecutive scans of the signals being analized. Normally it is a multiple of 10 mSec (PLC scanning time).The default value is 10 mSec.

To analyze quickly changing phenomena such as axes responses or traces of variables used in the superfast logic section, a time base may be used which is equal to the axis standard defined during configuration.

It must be noted that it is not possible to analyze signals using a time base which is smaller than their update times. For example signals from the high speed logic section (which have a scanning rate of 10 mSec), the time base used should be 10 mSec.

A 2 mSec time base may be used to analyze the dynamics of the machine axes, thereby displaying instantaneous speed, path error, or other analog outputs.

ACQUIRE TIME This is the time period specified for analyzing the signal in question. The number of PAGES is calculated based upon this number and the time base, which is then rounded to the highest multiple of 2. Each page contains 512 points separated by a distance equal to the time base. The maximum number of pages is 8.
Example: ACQTIM=30 Sec; TIMBAS=10 mSec
(30/.01)=3000 values must be acquired; these are divided into (3000/512)=5.86 pages, which is rounded up to the highest multiple of 2, that being 8.

FORCED VALUE Permits the value of a variable to be forced and to immediately gauge its effect. (see description further ahead)

NAME/EXP TRIGGER Permits the insertion of an equation (written within parenthesis using a valid PLC syntax), or a signal which, when it assumes the value zero, activates the storage of the analyzed signal according to the position of the trigger selected.

TRIGGER TIMING This key establishes the trigger position with respect to the signal acquisition time. In other words, the display time may be posted before, after, or in time with the trigger.

Pressing this key will cycle the trigger position between three distinct selections:

- ***PRE****:* trace before trigger
- ***MID****:* trace in time with trigger
- ***END****:* trace after trigger.

ACQUIRE After having chosen the above display settings, the analyzer must be activated. Only then the acquisition is activated and three trigger equation checked.

When the trigger equation is satisfied the percentage of actual acquisition time will be displayed until 100% is achieved, at which time the ***ANALYZE TRACE*** menu appears.

If the ***ACQUIRE*** key is pressed without having set the trigger parameters, the analyzer continuously scans the display signals until the key is pressed again. This application may be useful for example when calibrating movement or position.

..MORE.. Activates a new menu with other functions.

The ***..MORE..*** softkey calls up the following menu containing functions as described ahead:

.

FIND ASSIGN. By supplying a variable name used in the active PLC program this function searches all assignments of that variable, the relative equations are then displayed between the expressions to be traced.

EXPAND EQU. Permits the expansion, or separate tracing of each of the terms contained within the equation highlighted by the cursor. This function is usually used after an assignment search (SEARCH ASSIGNMENT).

DELETE ALL Deletes all names and expressions of the present traces.

STORE VAR LIST Stores graphic analyzer names and expressions in a table, to be recalled later using ***RECALL LIST*** The name of the table must be entered, then press Return .

Trace analysis

Activating the trace analyzer ***ANALYZE TRACE*** allows the quantification of signal acquisition times and values, it also allows the changing of the display scale and the number of pages with which the traces are displayed.

It is always possible to observe on the display:

- The time base for acquisition of the traces (preceded by the symbol **BT**:)
- The acquisition duration time(preceded by the symbol **FR**:)
- Horizontal cursor time intervals (**CURSOR** + and **CURSOR#)**
- The reduction factor for that which is being analyzed (preceded by the symbol **X**)
- The percentage of time between the trigger arrival and the total acquisition duration
- The trigger position (preceded by the symbol **TP**).

There are two cursors available called + and #, which once activated by their relative softkeys **CURSOR+** and **CURSOR#,** may be moved using the horizontal . → and ← arrow keys to measure changes in time.

The ↑ and ↓ arrow keys move two other cursors also called **+** and **#.** These are activated simultaneously with the horizontal cursors and permit the selection of variables whose numerical value is questioned by positioning the cursor on the trace. These values are displayed on the lower portion of the screen in the same color as the trace they represent.

Zooming in and out on a trace is performed by using the PgUp and PgDn keys, the scaling factor is 1,2,4, or 8. The softkeys present in the ***ANALYZE TRACE*** menu are as follows:

ACQUIRE	CURSOR +	CURSOR #	CURSOR SPEED	HIGHLIGHT TRACE

REDISPLAY TRACE	ADJUST SCALE	SAVE TABLE

ACQUIRE The analyzer may be activated using this softkey, after having made modifications to the parameters controlled by this menu.

CURSOR +
CURSOR # Turns ON or OFF the horizontal and vertical cursors.

CURSOR SPEED Permits the adjustment of horizontal cursor speed.

HIGHLIGHT TRACE By pressing this softkey the trace selected by the cursor becomes a reverse image. The traces so highlighted are not redrawn when the ***REDRAW TRACE*** key is pressed.

When the ***REDRAW TRACE*** key is pressed after this operation is performed, only the non-highlighted traces are retraced. This function may be used to analyze a large number of traces one at a time, or in small groups.

traces selected are stored in memory and to recall them it is necessary to position the cursor on the signal name and press ***HIGHLIGHT TRACE*** until the selection is made, then press ***REDRAW TRACE***.

REDISPLAY TRACE Moves and redraws the traces in such a manner to position the cursor as close to the screen center as possible.

ADJUST SCALE Permits the change of max and min limits for a selected trace using the vertical cursor; by making the modifications and pressing the Return key the trace with its new limits will be displayed.

STORE TABLE Stores graphic analyzer names and expressions in a table, to be recalled later using RECALL TABLE. The name of the table must be supplied and then press Return.

The analyzer may also capture **glitches**, which may happen when a time base of greater than 10 mSec is used to analyze a signal and all that is displayed is a point, which indicates that the signal was moving slower than the base selected, and capture in 10 mSec interval.

If a graphics printer is available a hard copy of the display may be made by pressing the Ctrl + Print keys (to obtain the analyzed data only), or Alt + Print (to obtain a copy of the whole screen). This document may be useful for maintenance purposes.

Storing traces

After the traces of signals have been acquired by the graphic analyzer, it is possible to store them in a file by pressing the softkey ***STORE DATA***, and naming the file.
To display the data acquired at a later time, press the softkeys ***DEBUG LOGIC***, ***SELECT DATA***, ***RECALL TABLE***, ***START ACQUIRE.***

2.5.3. DISPLAY AND ANALYZER TABLES

The function of these tables is to group the display variables used for analysis of problems of known origin. The tables, that is the list of variables and equations to be used with the graphic analyzer and dynamic displays, can be edited as any other program or more simply by the operation ***STORE TABLE*** within the graphic analyzer or dynamic display.

The softkeys ***VISUAL TABLES*** and ***ANALYZER TABLES***, present in the ***DEBUG LOGIC*** menu, select the type of table on which to operate. After the selection, the following softkeys may be used:

MEMORY	FLOPPY DRIVE	FLASH MEMORY	EDIT FILE	RECALL TABLES		RENAME PROGRAM	COPY PROGRAM	DELETE PROGRAM

EDIT TABLE Allows editing previously stored variable names.

RECALL TABLE Recalls a table previously stored which contains display and trace variables.

A file name must be supplied by the user or selected with the arrow keys for each of these two functions, after which the Return key must be pressed.

2.5.4. FORCED ASSIGNMENTS

During the course of debugging it may become necessary to force a binary value or numerical value a variable. The ***FORCED ASSIGNMENT*** function is provided for this purpose and once activated the signal name and desired value will be requested and entered via the key pad.

namevariable=expression
press Return.

The forced value will not change until an instruction modifies it or until the NC is turned OFF in the case of non-retained variables.
It is not possible to force input values since they are refreshed at each PLC scan.

2.5.5. FORCED VALUE TABLES

When many variables must be assigned a new value the softkey ***FORCING FILES*** in the debug logic menu is used.
By pressing this softkey the following menu appears:

MEMORY	FLOPPY DRIVE	FLASH MEMORY	EDIT FORCE FILE	RECALL FORCE FILE		RENAME PROGRAM	COPY PROGRAM	DELETE PROGRAM

EDIT FORCE FILE Allows editing previously stored variable names.

.

RECALL FORCE FILE Recalls a previously stored file which containing display and trace variables.

A file name must be supplied by the user or selected with the arrow keys for each of these two functions after which the Return must be pressed.

2.5.6. RESET STATIC RAM

The static ram may be reset using a softkey contained in the following menu, which is accessed from the main menu with the ***DEBUG LOGIC*** softkey.

ENABLE PLC LOGIC	DYNAMIC DISPLAY	GRAPHIC ANALYZER	PLC LOGIC MESSAGES	CROSS REFERENCE	SCREEN TABLES	ANALYZER FILES		FORCING FILES	RESET SRAM

By pressing the softkey F10 the static RAM is deleted and the NC restarted.

2.5.7. CROSS REFERENCE GENERATION OF USED VARIABLES

Cross reference is a file where all variables and signals used within PLC program are listed in alphabetic order with an annotation included at the moment of the declaration and in order the line numbers where they are used.

The syntax is as follows:

NAME_VARIABLE	**num_line_declaration**	**annotation**
<num. line...	**line where NAME_VARIABLE is written**	
>num. line...	**line where NAME_VARIABLE is read**	

The ***cross reference*** may be generated only if the PLC program has been compiled.

By pressing **LOGIC BEBUG** softkey and then **CROSS REFERENCE** the following menu will appear:

MEMORY	FLOPPY DRIVE	FLASH MEMORY	EDIT	CROSS REFERENCE	SELECT SOURCE	SELECT CROSS REF.	RENAME PROGRAM	COPY PROGRAM	DELETE PROGRAM

With the prompt on the active PLC file press ***CROSS* REFERENCE** and wait for few seconds.

At the end of this operation press ***SELECT CROSS REF.*** a file will be created with the same name as the PLC program, containing the **cross reference**.

All the other softkeys have the same function common to all the other environments of NC.

2.6. PLC TABLE MODIFICATIONS AND DISPLAYS

The variables array (tables to the user) declared internally by the PLC program can be displayed and modified by the user given that the names are known.

Pressing the softkey ***OFFSETS / PARAMETERS*** from the main NC menu accesses the softkey ***PLC TABLE***. After pressing this key enter the name of the file to be modified then press Return.

The array elements and their current values will be displayed side by side it is then possible to change the values presented and transfer them to the PLC.

2.7. FAST KEYS

By using certain combinations of keys it is possible to quickly access the applications environment from any menu:

Ctrl + F1	to execute programs from memory
Ctrl + F2	to activate dynamic display
Ctrl + F3	to activate graphic analyzer
Ctrl + F4	to access peripherals menu
Ctrl + F5	to modify the NC configuration.
Shift + F1	These keys access a menu to modify dynamically, certain axis parameters (modified by the PLC- see *Part II - System Interface*). The values modified in this environment are applied immediately.

The axis configuration files are updated only when the ***UPDATE FILE*** softkey is pressed.

3. PROGRAM ORGANIZATION

3.1. GENERAL RULES

The following rules should be kept in mind when writing a program:

- Each PLC program must have a name containing up to 8 uppercase alphanumeric characters. The first character must be a letter of the alphabet. The name may not contain blank spaces.
- PRN, AUX, COM1, COM2, COM3, COM4, LPT1, LPT2, LPT3, LPT4, CON, NUL may not be used as names for programs.
- All symbols and variables must be defined by mnemonic names within uppercase alphanumeric strings up to 6 characters in length.
- All symbols must begin with a letter and may not contain the following characters:
  ^ ? ! \ # % & | ~/ ( ) > [ ] < + - * @ = " ' , : . ; blank spaces
  Because these are special control characters or are reserved for logic and arithmetic expressions. The blanks are ignored during compiling of instructions.
- Words used to describe key functions or system variables may not be used as names.
- The use of long expressions is discouraged however, it is possible to edit these expressions by using the $ at the end of the line before starting on the next line.
- The maximum line length for a logical expression in a PLC program is 500 characters, excluding blank spaces (these may be tied together on several lines using the $ sign).
- It is possible to write more than one equation on a single line by separating them with a ";" (semi-colon).
- "LABELS and symbols are always followed by a ":" (colon).
- The comments within a program may be placed at any position as long as they are preceded by the "[" symbol. It is recommended that many comments are used to ease of troubleshooting the program, since they do not occupy extra memory space when the program is compiled.
- In order to change from the maximum of 6 characters allowed in the definition of variables (default) to 9 or 12, enter these instructions at the start of the PLC program:
  CONST
  _MXCHR=6 (or =9, =12)

(The default is _MXCHR=6).
It must be remembered when using long names for variables that not only will the source printout naturally occupy greater space in memory but larger size exec files will also be generated.

3.2. PROGRAM STRUCTURE

Programs are divided into sections and entered in the sequence shown below. Each section must be preceded by it's heading:

INP . . . . ***OUT***	*Declaration section*	
INIT	*Initialization section* (used only where necessary)	
FAST	*Superfast section* (use only when absolutely necessary) (if not used remove the key word FAST)	*PROGRAM*
PROG . . . . ***END***	*Fast section* (used only where necessary)	
. . . . ***END***	*Slow section* (ordinary logic)	
. . . . ***END***	*Super slow section* (used only where necessary)	
. . . .	*Routines section* (used only where necessary)	

3.2.1. DECLARATION SECTION

All of the following variables must be declared by name in the order indicated in this section.

Next to the name, it is helpful to insert a brief description of the variable so that the program may be read and understood by all. For example next to inputs and outputs the connection number and bit names can be referenced.

The declaration of each group of variables must be made prior to the corresponding key word (see *chapter 4, Initial Declarations*).

3.2.2. INITIALIZATION SECTION

Initialization is an optional section following the declaration section.

This section, in which inputs and outputs may not be read, allows previously declared variables to be initialized or reset on power up.

The beginning of the initialization section is recognized by the symbol **INIT**.

3.2.3. PROGRAM SECTION

This is the section containing the instructions for the PLC to cycle through. This section may be subdivided into four more sections:

SUPERFAST LOGIC
FAST LOGIC
SLOW LOGIC
SUPERSLOW LOGIC

Superfast logic

The optional *SUPERFAST LOGIC* section comprises all of the instructions written between the keywords **FAST** and **PROG**. These instructions are intended exclusively for operating on parameters ***which change very quickly***, and for repetitive acquisitions such as each test of the NC axis position, (see the configuration documentation). It is necessary to remember that these types of instructions require ten times more CPU processing time.

If the maximum time limit for this section is exceeded the following message will appear:

Superfast cycle too long.

Fast logic

The *FAST LOGIC* section is comprised of the instructions written between the key words **PROG** and the first **END**, which are cycled every 10 mSec.

If the maximum time allowed for this section is exceeded the following message will appear:

Fast cycle too long.

Slow Logic

The Slow logic section is comprised of the instructions written between the first and second **END**.

This part of the program is executed in the time left between the fast logic executions and the time allotted for the PLC. If this time is not sufficient the Slow section is broken into more cycles.

Superslow logic

The *SUPERSLOW* logic section is comprised of the instructions written between the second and third **END,** and are executed with lesser priority for such slower phenomena as (thermal compensation, message management), and may be further divided into more cycles.

Syncronization

The *SUPERFAST, FAST*, and *SLOW* sections are executed in sequence after the **INIT** section. The super slow logic is not necessarily in sequence with the others.

The INPUTS are read at the beginning of the superfast cycle, when present, and the OUTPUTS are written at the end of the same cycle.

If the superfast section does not exist, the inputs are read at the beginning of the fast cycle and the OUTPUTS are written at the end of the same cycle.

3.2.4. ROUTINES SECTION

Any Routine used only in a certain section (FAST, etc.), can be written directly inside that section. A routine written for a certain section is often valid for other sections, too, so it is advantageous to write it at the end of the program, that is, after the third **END** instruction (see *Chapter 6, instruction for program controls*).

3.3. VARIABLE AND NUMBER FORMAT

The program variables may be classified as follows:

***BIT**:* elementary logic signal with a value of 1 or 0, (true or false)

***BYTE**:* 8 BIT variable containing whole numbers between -128 and 127

***WORD**:* 16 BIT variable containing whole numbers between -32768 and 32767

***LONG**:* 32 BIT variable capable of positive and negative numbers between 1.2×10^{-38} and 3.4×10^{38} in floating point format, with 7 digits in the mantissa.

***DOUBLE**:* 64 bit variables capable of positive and negative numbers between 2.2×10^{-308} and 1.8×10^{307} in floating point format double precision, with 15 digits in the mantissa.

***STRING**:* a settable variable containing alphanumeric characters in ASCII format.

Decimal numbers may be written in the following format:

± *integer.decimal* (ex. -12.678)

± *integer.decimal e ±exponent* in scientific notation (ex. 12.3e-3).

Hexadecimal formatted numbers must contain an **H** suffix and must be preceded by a 0 if the most significant figure is greater than 9 (ex. 0FA23H).

Similarly the Letter **B** is used for binary numbers (ex. 01011101B).

For example the decimal number 35 corresponds to 23**H** in hexadecimal and 00100011**B** in binary; the decimal number 195 corresponds to 0C3**H** in hexadecimal and 11000011**B** in binary.

For the declaration of variables (numerical and string) see the appropriate sections in chapter 4.

3.3.1. VECTOR AND SINGLE VARIABLES

The (***internal)*** variables of the system are either single or multidimensional arrays. The former represent only one element while the latter represents many elements under one name. These have names which begin alphanumerically then are followed by parenthesis which contain a number (called an INDEX) which identifies the element. The format for the ***vectorial*** or ***matrix*** variables is as follows:

name (index)

The vectorial variables can be formatted in any of the ways described above. It is obvious that all of the vectorial variables must be formatted identically, that is (BYTE, WORD, etc.) within each variable.

The index parameter may be:

- a whole number between 1 and 32767

  Example:

  TABX(122) = 44.6565 *The number 44.6565 is written inside the element 122*
  TABX(45)=TABX(77)+TABX(23) *The element 45 contains the sum of elements 77 and 23.*

- a BYTE variable name between 1 and 127, or a WORD variable between 1 and 32767

  Example:

  Suppose that the variables BTAB and WTAB have been established as a BYTE and WORD respectively;

  BTAB=18: 18 is written to the variable BTAB
  TABUT(BTAB)=25: 25 is written to the 18th element of TABUT
  ...
  WTAB=199: the value 199 is written to WTAB
  VALORE=TABCOY(WTAB): the contents of the 199th element of TABCOY are written to the single variable VALORE.

- an expression which results in a BYTE or WORD format with the same numerical limitations as the preceding case.

  Example:

  Suppose that DAT01 and DAT02 are single variables in BYTE format and that ARRAY(x) is a vectorial variable with more than 11 elements.

  DAT01=4

DAT02=6
ARRAY(DAT01+DAT02+1)=66 : 66 is written to the 11th element of ARRAY.

In general the vectorial variables occupy contiguous locations within memory, therefor it is important to pay particular attention to the length and quantity of data handled by these variables to avoid invading other variable's space. (see further ahead). In fact, if the index value is greater than the number of elements declared by the VECTOR, they will occupy the next memory location.

Negative Index values, values of zero or values outside the range (ex. 45000) must be avoided at all costs, else non-related memory locations may be overwritten.

3.3.2. STATIC AND DYNAMIC VARIABLES

Program variables may be static, and maintain their value after the controller is turned OFF, or dynamic, in accordance with the declaration which was made (see Declaration of Internal Variables in the next chapter).

Dynamic (numeric) variables assume values of zero when the NC is turned ON, and string values assume the value (empty string)

COUNTER values are stored during shut-off, however the values for TIMER, PULSE, and SOFTKEY are not.

Of the internal variables, those associated with the axes positioning (independent and controlled) are static.

3.3.3. CONSTANTS

It may be useful to describe constants within a program (numerical and string); in these cases the values are assigned during initialization of the program to avoid repeating the same instructions.

Example:

```
INIT
SMAX=3500
ALLM= 'SPINDLE OUT OF SERVICE'
```

The system makes available the following predefined mnemonic symbol:

PI=3.1415927 PI in DOUBLE format.

3.3.4. CONFIGURABLE CONSTANTS FOR MACHINE LOGIC

To utilize machine logic on other similar but not identical machines it is necessary to assign a certain amount of configurable constants at the time of installation.

This allows for setting parameters, at the PLC level, for lubrication, tool change reports, timer intervals, axis position, etc..

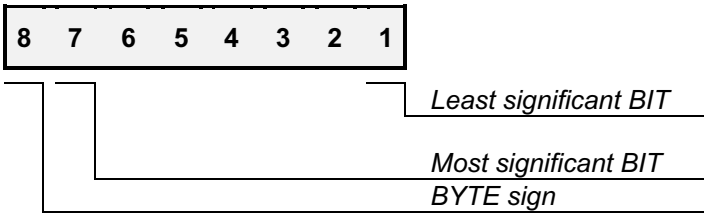
For this purpose the following constants are defined for configuration:

- 16 machine constants common to the whole system called; KMF(1), KMF (2), KMF (3),..,KMF(16) - in 32 bit floating point.
- 32 constants called; KMW(1), KMW (2), KMW(3),..,KMW(32) -in word format.

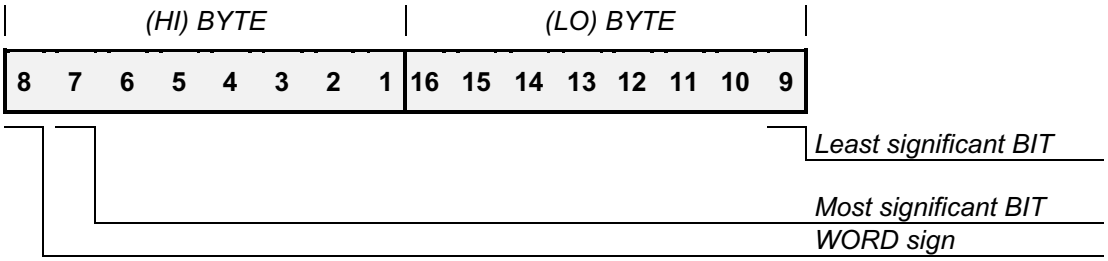
3.3.5. DISPOSITION OF SINGLE BITS INTERNAL TO THE VARIABLES

The disposition of single bits internal to BYTE, WORD are as follows:

BYTE Format



WORD format



Note:

BYTE and WORD are used by the PLC in signed binary format; that is negative numbers are represented in 2's complement.

Example:

```
BYTE      1  =  0 0 0 0 0 0 0 1 B
             -1  =  1 1 1 1 1 1 1 1 B
                                  sign bit

WORD      1  =  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 B
             -1  =  1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 B
                                                  sign bit
```

3.3.6. ACCESS TO VARIABLE BITS

Single Variables

To access the bits within a variable the variable is treated as an eight element matrix if it is a BYTE, or 16 element matrix if it is a WORD, etc.The following matrix syntax is used:

var(*index*)

index may be one of the following lengths (in the examples the variables are single and not vectorial):

- An integer between 1 and the maximum number of bits for that variable.

  Example:

  BIT3=NUMBT(3) with this function, BIT3 will equal 1 or 0 depending on the state of the third bit in NUMBT.

- the name of a variable of the type BYTE or WORD which may assume values between 1 and the maximum number of bits to be operated on.

  Example:

  INDEX=5
  BYTE1(INDEX)=1 puts a 1 in bit 5 of BYTE1

- an expression resulting in the BYTE or WORD format with the same limits as the previous case

  Example:

  DATO1=8
  DATO2=6
  WORD1(DATO1+DATO2+1)=0 places a 0 in the 14th bit of the variable WORD1 in word format.

In each case it is necessary to remember that, if the value of the index exceeds the formatted value, memory locations adjacent to the locations of the variable will be overwritten, these may presumably be occupied by other variables.

Index values of zero must be avoided, as should negative values and out of range values as described above.

Vectorial variables

In the case of vectorial variables, if a bit from a vector element must be read it is easier to copy the empty element to a dummy variable, thereby accessing only the single bit.

Example:

Suppose that the variables CONFI(X) and TEMPOR are WORD types

TEMPOR=CONFI(2) The 2nd element of *CONFI* is copied to *TEMPOR*
BIT12=TEMPOR(12) the variable *BIT12* equals the 12th bit in *TEMPOR*.

If, instead, a single bit of a vector element is to be written, it is necessary to first write the bit to a dummy variable and then overwrite the element of the vector with it. For more information on bit handling see chapter 5, *Functions and Operations*.

3.3.7. ACCESS TO BITS OF ADJACENT VARIABLES

If the index value exceeds the formatted value, as described earlier, the adjacent bits will be overwritten as follows:

Examples:

Suppose the variables VAR1, ALARM, and CONFIG are BYTE types and that VAR2 and FLAGS are WORD types; the following bits are accessed (in bold) with the expressions shown on the right:

VAR1	8	7	6	5	4	**3**	2	1	VAR1 (3)
ALARM	8	7	6	5	4	3	**2**	1	VAR1(10)=ALARM(2)
CONFIG	8	7	6	5	4	3	2	1	

HI VAR2	8	7	6	5	4	**3**	2	1	VAR2(3)
LO VAR2	16	15	14	13	12	11	10	9	
HI FLAGS	8	7	6	5	4	3	**2**	1	VAR2(18) = FLAGS(2)
LO FLAGS	16	15	14	13	12	11	10	9	

4. INITIAL DECLARATIONS

All of the symbols used in the PLC program must be declared at the beginning of the program using one of the following keywords described in greater detail further ahead in this chapter.

INP	physical input
TERM	skip unused inputs
OUT	physical output
TERM	skip unused outputs
SRAM	variable stored in non-volatile RAM (not lost when power is lost)
RAM	variable stored in volatile RAM. (lost when power is OFF to NC)
STR	string
EQU	equivalence or synonym
PULSE	derived impulse
FTIMER	fast timers
STIMER	slow timers
COUNT	counters
LANG	languages of the sotfkeys
SOFTK	softkey

NOTE:
Not all of the declarative functions listed above are required but when used must appear in the order shown.

Also when variables of different data format sizes are used they must be declared in order starting with the larges format.

Example:

SRAM,64	the names which follow are in DOUBLE format
NOMEA	
...	
RAM,32	the names which follow are in LONG format
NOMEF	
...	
SRAM,16	the names which follow are in WORD format
NOMEL	
...	
SRAM,8	the names which follow are in BYTE format
NOMEP	
...	

4.1. DECLARATION OF PHYSICAL INPUTS / OUTPUTS

The program must always begin with the declaration of the inputs and outputs physically connected to the unit.

Inputs and outputs are referenced directly to their physical I/O board terminations. For example the first input declared after the INP keyword is assigned to terminal 1, the second to terminal 2 etc.

For input wires the key word INP must be used in the following format:

INP[,attribute][,connector number]
Input Name 1
...
Input Name n

For output wires the keyword OUT must be used in the following foprmat:

OUT [,attribute] [,connector number]
Output name 1
...
Output name n

Where:

[**,attribute**] defines the type of variable;
,1 describes 1 bit (default value when attribute omitted)
,8 describes a byte
,16 describes a word

[**,connector number**] indicates the position on the I/OMIX board where the connector is located* (see system Installation Manual).

*The default is 1 if this parameter is omitted.

After declaring the types of inputs/outputs a list of all the variable names for those types must be made.

Example:

INP
NOMEA *name of input 1*
NOMEB *name of input 2*
NOMEC *name of input 3*
OUT
NOMED *name of output 1*
NOMEE *name of output 2*

This determination assigns three names to the first three inputs and two names to the first two outputs all are bit types.

The I/O expansion boards follow the same rules as the main I/O board.

Example:

Configuration: -1 I/OMIX board in slot 1
-2 Digital I/O expansion boards (I/OD)

In this case the declaration of the INP must be:

INP[,attribute][,1]
NAME1 *input number 1 on main board*
NAME2
...
NAME96 *input number 96(last input) on the second expansion board*

The numbering and configuration of the I/O on each board is described in the Installation Manual.

Instead, in cases where a group of 8 or 16 signals exist which must be treated as a single unit, it is helpful to define them as a BYTE or a WORD. In such instances, to access a single signal from the group the rules for the access to variable bits apply (see access to variable bits in the preceding chapter).

Example:

INP,8
NAME

or:

INP,16
NAME

In general it is possible to have a double declaration for mixed treatment via a syntax of the type:

group:[name1][,name2][,...][,namen]

Where ***group*** refers to the group of signals and ***name1...namen*** refer to the single bits with ***n*** being limited by the length of the description and can be no greater than 8 per BYTE or 16 per WORD.

All of the terms following the group name (name1..namen) are optional. This mean that any element may be omitted from the list including terms from the right and terms from the left.

In the cases where no intermediate names are given, the names can be omitted but the corresponding comma must be kept. A comma is not needed after the last name. The compiler automatically truncates the signal description at that point.

Example:

INP,8
INGR1:LIVOIL,IPLUBE,,,TERMAX,TERMAY

Sometimes there are gaps in the physical sequence of input or output connections. In this case it is necessary to define the number of the last non used terminal with the function **TERM**, and continue by declaring all remaining signals. The format for said function is as follows:

TERM,number

If ***number*** is a bit it may take any value, however if it is a BYTE it must be a multiple of 8, and a multiple of 16 if it is a WORD.

Example:
INP
IFCXP [input1
TERM,5
ISPOK [input6
For the listing above, the terminals from 2 - 5 are not used, and the program restarts from the 6th terminal with the signal ISPOK.

If the parameter “I/O access diagnostic” is enabled in the installation setup, if you attempt from PLC or logic debugging to access in read or write a resource that is not present, the following message appears: "**E1994**: access to missing component" followed typically by the number of the PLC line where the inconsistency was found.
The diagnostic checks for consistency between the addressing and that resources accessible from PLC are actually present (i.e., digital inputs and outputs, analog inputs and outputs, heat probes).

4.1.1. PHYSICAL INPUT/OUTPUT DECLARATION: REMOTE I/O MODULES

To address the digital I/O on remote modules, use the extended INP or OUT declaration, followed by a list of the Names of the variables.

For the INPUT terminals, use the INP declarative with the following format:
INP,attribute,master board number,slave number
input 1 name
. . .
input n name

and for the OUTPUT terminals:
OUT,attribute,master board number,slave number
output 1 name
. . .
output n name

Where:

attribute Defines the input type. May be:
,1 describes 1 BIT only (default value if attribute omitted)
,8 describes a BYTE
,16 describes a WORD

master board number indicates which BOARD SLOT the board with RIO master interface will have, like the case of local I/O where it relates to the I/OMIX board. If the master board with integrated RIO is used, the board number will be 17.

slave number declares the address set with the microswitches on the remote module.

Example:

INP,1,17,60	*bit format input, master17, slave 60*
NAMEA	*name of input number 1*
NAMEB	*name of input number 2*
NAMEC	*name of input number 3*
OUT,1,17,60	*bit format output, master17, slave 60*
NAMED	*name of output number 1*
NAMEE	*name of output number 2*

4.2. DECLARATION OF INTERNAL VARIABLES

Internal variables are defined as those variables or signals needed for calculations or internal storage not directly connected to the physical signals.

Depending on whether or not the variable must be retained after shutting off the NC, two types of variables may be declared:

SRAM[,attribute] variables to be retained
Internal variable1
...
Internal variable n

RAM[,attribute] variables not to be retained
Internal variable 1
...
Internal variable n

where;

[,attribute]	may assume the following values via the declarative:
,1	to indicate a variable of BIT format (value of default, if omitted)
,8	to indicate a variable of BYTE format
,16	to indicate a variable of WORD format
,32	to indicate a variable of LONG format
,64	to indicate a variable of DOUBLE format

Besides the types RAM,x and SRAM,x, there is also the possibility of managing variables, called SSRAM, which are not reset by the usual NC reset operations or by recompiling the PLC.
The SSRAM can be given the same sizes as the normal SRAM.

Example:

```
SSRAM,16
ORELAV          [machine working hours counter
```

The space available for the **SSRAM** is very limited (96 bytes); the area relative to these variables is reset when a PLC is compiled with inside an **SSRAM** declaration different from the previous one.

S1200 In the S1200 variables declared as (***RAM [,attribute]***) were implicitly retentive

Vector arrays (tables) may also be used as for internal variables, in all formats except bit format.

Therefore we have:

name(number):[name1][,name2][,....][,namen]

number indicates the vector index. If the vector has a certain dimension previously declared, the names to the right of the ":" indicate the names of each element in the same format as the vector.
In case some names are not given, it is necessary only to leave the commas in their places.

Commas are not needed after the last name; the compiler truncates the signal description at that point.

The number of vector elements may be as high as 32767 depending on the amount of memory available.

As was said earlier, the LONG and DOUBLE variables, being of floating point format, are always used for mathematical calculations.

4.3. DECLARATION OF STRINGS

Strings are variables which contain alphanumeric characters in ASCII format. Generally the declaration is used for storing messages.
The declaration of string names is effected after the key word:

STR[,attribute]
String variable 1
...
String variable n

where:

[,attribute]	may assume the following values:
,16	for strings with a maximum length of 14 characters
,32	for strings with a maximum length of 30 characters
,64	for strings with a maximum length of 62 characters
,128	for strings with a maximum length of 126 characters
,256	for strings with a maximum length of 254 characters

The default value is **64** in cases where the attribute is omitted. If an attempt is made to write a string longer than the declared length, it is automatically truncated and an error message is shown on the display.
It is possible to use vectorial declaratives even for strings:

- Using the explicit format the name of every attribute is listed:

```
STR
NAMEA
NAMEB
```

- Using a matrix type format the name and total number of elements are specified:

```
STR
NAME(n)
```

Example:

```
...
STR,64
NAMEA
MSG(12)
...
PROG
...
NAMEA='SAMPLE MESSAGE'                  assign contents of variable string NAMEA
MSG(2)='SPINDLE PROTECTION STOP'    assign contents of vector variable string MSG(2)
....
```

4.4. DECLARATION OF EQUIVALENCES

Using equivalence, different names may be assigned to variables already defined in earlier declarations.

The equivalence function is as follows:

EQU[,attribute]
name1:name2
...
namem:namen

where the format of the variable being introduced is declared by the value of the ***attribute*** and therefore may assume all permissible values for internal variables (1, 8, 16, 32, 64).

The assignments which follow must be of the type:

namex:namey

where ***namex*** is the new symbol to insert and ***namey*** is a quantity that must have been already declared.

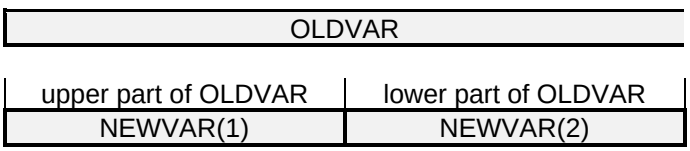
Example:

```
RAM,8
ARRAY(10)
...
EQU,8

NAMEX:ARRAY(3)      The new variable NAMEX describes the third byte of ARRAY, which was
                    defined earlier as having 10 elements
[
EQU,16
WORD:ARRAY(1)       the variable WORD refers to the first two bytes of ARRAY.
```

In addition to the syntax of the preceding example it is possible to declare a new vector operand.

Example:

```
RAM,16
OLDVAR
EQU,8
NEWVAR(2):OLDVAR

Where   NEWVAR(2) is a two element vector of BYTE format
in which NEWVAR(1) is equivalent to the upper part of OLDVAR
and     NEWVAR(2) is equivalent the lower part of OLDVAR.
```



By way of the declarative **EQU,** equivalences can be assigned between string variables and byte vectors.
This is a useful feature if wishing to dispose of a vector containing the ASCII characters of a given string.

```
Es.
STR
BUFSTR                  [string variable
[
EQU,8
VETSTR(64):BUFSTR   [I associate a 64 byte vector with the string
[
PROG
BUFSTR='ABCD'
[
[VETSTR(1)=0            [this byte is always at 0
[VETSTR(2)=4            [the second byte contains the string length
[VETSTR(3)=65           [ASCII code for letter A
[VETSTR(4)=66           [ASCII code for letter B
[VETSTR(5)=67           [ASCII code for letter C
[VETSTR(6)=68           [ASCII code for letter D
[VETSTR(7)=XX           [... other
```

4.5. PULSE

The pulse function is derived from the rising edge of a signal. Its purpose is to create an impulse seen only once by every logic equation. It is enabled at the beginning of the slow logic section when the generating equation or variable changes from a "zero" (0) logic level to a high logic level (1), and is reset when the slow logic section is completed.

Pulses programmed in the fast logic sections do not terminate until all logic sections have been executed. It is necessary that the generating variable lasts the minimum capture time to activate an impulse equal to a complete scan of all the logic. This will ensure that the pulse is also detected in the slow logic section.

For the technique of synchronization described, consider that the rising edge of the pulse generally does not overlap the rising edge of the generating signal, but instead lags it by a time period which may equal or exceed a complete scan of the PLC program.

Note: The pulses are not retentive, therefore when the NC is turned ON, if they are associated with a signal already at a 1 state (eg: an input), they will generate a pulse.

The equation declaring a PULSE is written as any other signal in the program. For easy identification signal names should be derived from the name of the signal that triggers them (eg: Pstart for a pulse generated by the signal START). Pulses are declared in the same way as any other signal.

Up to 64 PULSES may be defined in the declaration section, using syntax:

PULSE
namea
...
namen

Example:

```
PULSE
NAMEA
NAMEB
...
...
PROG
NAMEA=(NCMD=5)      the namea signal is an NC pulse in manual mode
...
NAMEB=EMEA          the nameb signal is an NC pulse in Emergency mode
```

4.6. TIMERS

There are 32 fast timers available to the user, with a base time of 10 mSec (one cycle), capable of counting up to 327.67 seconds, and there are 64 slow timers with a base time of 100 mSec (10 cycles), capable of counting up to 3276.7 seconds (about one hour).

Timers are declared as such in the declaration section of the program, however their duration must be declared inside the program at the points where they are used.

Timers must be defined after the declarative **FTIMER** (fast timer) or **STIMER** (slow timer) by the following syntax:

FTIMER (or STIMER)
input, output, derived, stop, count
...
input, output, derived, stop, count

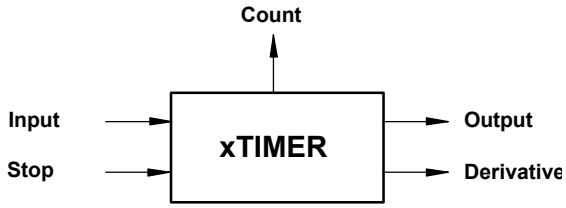
or

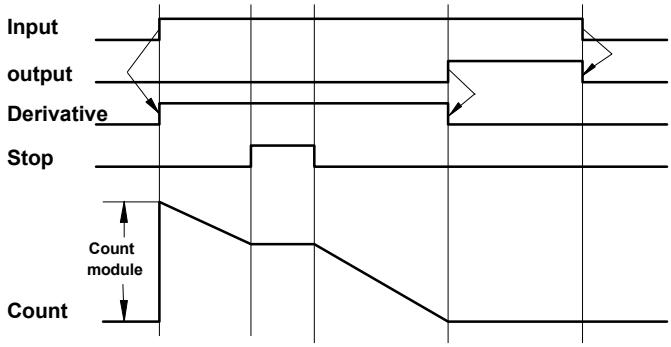
FTIMER (or STIMER)
input, output
input, output

where:

input is the name of the signal that activates the timer
output is the name of the time delayed output signal
derivedis the name of the signal that is active during the delay time
stop is the name of the signal that can be used to freeze the count
count is the name of the WORD which contains the current count

The functional display of the timer is as follows:





Note: The timer output remains high (1) as long as the input is high.

INPUT I f equal to 1: the timer counts according to its base time.
If equal to 0: the output is zeroed, but the count value is left unchanged. The timer counter is reloaded when the input changes from 0 to 1.

STOP With the transition from 0 to 1 the values are frozen and the timer is disabled. With the transition from 1 to 0 the timer restarts from the point where it was frozen.

OUTPUT Goes to 1 when the set time has elapsed.
Returns to 0 when the input goes to 0.

DERIVATIVE Is at 1 during the counting interval

All timer variables may be read and written from the program, with the exception of the **output** (U) and **derived** signals (D) which may only be read.

The time parameter, which does not have to be defined in the declaration section, is assigned in the program section of the code when the timer function is used.

This allows timer functions to be modified during the course of the program using fixed or parametric timing.

To make the timer signals identical in any part of the program, they must be synchronized to the signal which defines their input. This implies that the condition of the timer output as well as its derivative, are updated only when the PLC program reads the timer input instruction.

The syntax for activating a timer within a program is as follows:

input(count modules)=expression

where the ***count modules*** may be:
- a number between 1 and 32767
- a BYTE or WORD variable with contents ranging from 1 to 32767
- an expression that results in a BYTE or WORD with the same range as above

Example 1:

```
FTIMER
T1I,T1U,T1D,T1A,T1W  declaration of timer 1
T2I,T2U,T2D,T2A,T2W  declaration of timer 2
....
PROG
T1I(25)=....         timer 1 set to 250 mSec fixed.
T2I(2*TIMBAS+10)....  timer 2 set as a function of TIMBAS
...
```

Example 2:

```
OUT
U1                          oscillator output
STIMER
T2I,T2U,T2D,T2A,T2W         declaration of timer 2
...
PROG
T2I(10)="“2U                timer 2 set to oscillate with 1 sec base time
U1=(T2W<5)                  square wave output with 1 sec period
```

4.7. COUNTERS

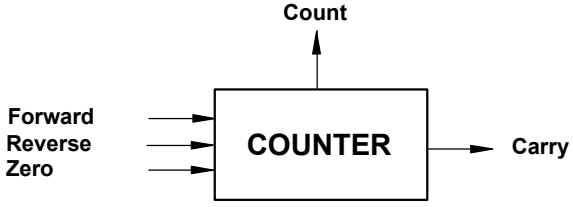
There are 48 up/down counters with programmable modules between 2 and 32767.
The counters, like the timers, must be defined in the declaration section, however the modules or quantity to be counted, must be defined inside the program. The declaration format is as follows:

COUNT
zero,forward,reverse,carry,count
zero,forward,reverse,carry,count

where:

zero: is the name of the signal which zeroes the counter
forward: is the name of the signal which advances the counter
reverse: is the name of the signal which reverses the counter
carry: is the name of the signal generated by the counter when passing zero
count: is the name of the WORD containing the cumulative count

The functional block diagram is:



The counter functions as follows:

zero: the count value goes to 0 when this signal changes from 0 to 1
forward: the counter increments at each rising slope of this signal
reverse: the counter decrements at each rising slope of this signal
carry: signals that the counter has passed through zero (ie that an OVERFLOW or UNDERFLOW occured).

The following figures illustrate both forward and reverse operation of a counter with modules 10.

Forward count

Zero	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	...
Forward	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	...
Count pos.	0		1		2		3		4		5		6		7		8		9		0		1		2	...
Carry	0		0		0		0		0		0		0		0		0		0		1		0		0	...

Reverse count

Zero.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	...
Reverse	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	...
Count pos.	0		9		8		7		6		5		4		3		2		1		0		9		8	...
Carry	0		0		0		0		0		0		0		0		0		0		1		0		0	...

During the forward count when the counter arrives at the module value the count is automatically set to zero. In the reverse count after arriving at zero the module value is loaded into the counter.

In these cases the zero transition is signalled by activation of the carry signal.

All of the signals named in a counter declaration may be read or written from within the program , except for the carry signal which may only be read.

The count parameter does not have to be defined in the declarative section, however it must be assigned in the program in the statement that sets the counter to zero.

This makes it possible to modify the counter action in the course of the program and allows fixed or parametric functions to be implemented.

The count module is loaded when the zero signal is released.

Example:

```
INP
ICOMAI                  crib reverse input count
COUNT
C1Z,C1A,C1I,C1R,C1C     declare counter 1
C2Z,C2A,C2I,C2R,C2C     declare counter 2
...
PROG
C1Z(50)=...             applies counter 1 with module count 50
C1I=ICOMAI              crib reverse input count decrements the counter
...
C2Z(TEMPO/60)=...       applies counter 2 defined by the variableTEMPO
```

4.8. LOGIC DEFINABLE SOFTKEYS

The system has 8 available function keys positioned vertically and located to the right of the display, which can be entirely defined and controlled by the machine logic and accessed by the function keys F11 and F18. In this way it is possible to enhance the man / machine interface via the menu for functions usually performed by switches and lamps, etc.., normally requiring additional NC inputs and outputs to connect these controls.

A softkey is treated by the system as an illuminated switch with a label.

Once the variables 'switch' and 'lamp' and the 'label' text are declared, the display will contain a new function key with the desired label capable of sending signals to the PLC, and also capable of being lighted by the PLC when in use.

There are 128 possible softkey combinations and are defined in groups of up to 8 menu elements, identified by the declaration ***SOFTK.*** The softkeys related to the same menu are displayed simultaneously and to change from one menu to the next an index attribute must be named or a PLC variable must be declared called (***SFKMEN***).

The '**switch**' signal may be momentary or continue for as long as the key is selected (pressed).

The softkeys may also be associated with a message or numerical string, to aid the operator with accessing data.

The easiest way of declaring a softkey menu is:

SOFTK,menu number
switch,lamp[,0/1],'label(text)'
...
switch,lamp[,0/1],'label (text)'

selecting ,**0**	indicates the switch is momentary and lasts only one PLC execution cycle (default).
selecting ,**1**	indicates the switch is on as long as it is pressed.

Menu number may be omitted when declaring the first menu.

Softkeys associated with messages or numerical variables

The definition of a softkey associated with a message or numerical variable is:

strobe,lamp,[switch,]'label','message',[FP:/STR:]variable[,default value]

In this example the switch signal is received by the PLC as soon as the softkey is pressed followed by the Return key. The message is subsequently displayed on the screen followed by the actual value of the associated variable. The strobe signal is sent to the PLC to signal a new variable value or to confirm the existing one.

The variable is implicitly defined as DOUBLE format (FP:) as long as there are no other specifications via the string format STR:

The default value, when defined, is always displayed on the command line in place of the current variable value when the softkey is pressed. It is not intended to be an initialization value for the variable when the NC is first turned ON.

SOFTKEY for menu call

When a softkey must call the next menu or return to the previous one, the syntax for creating the chain is as follows:

switch,lamp,'label',menu number

An alternative to this method is to select the softkey menu directly by writing the number into the PLC variable ***SFKMEN.***

This variable always contains the softkey menu number currently displayed, even when the menu change is effected automatically.

The respective formats for text descriptions are 18 characters on three lines for labels and 20 characters on the command line for messages. The message text may contain all characters except the quotes (" ").

Example:

SOFTK,1	first softkey menu
P1,L1,1,'JOG X +'	the label is JOG X + and the switch is on while pushed
...	
P7,L7,0,'REFERENCE AXIS'	the 7th softkey label is zero search & the switch is momentary
P8,L8,'DISPLACEMENT',2	the softkey with label DISPL calls the 2nd softkey menu
SOFTK,2	second softkey menu
P21,L21,1,'DISPLACE AXIS X'	first softkey of the second menu...

4.9 SOFTKEY AND MESSAGES WITH MULTILINGUAL TEXT

Sofkeys managed by PLC (F11 - F18) may be defined as “multilingual” mode in order to automatically adjust themselves to the selected language for the menus of NC (F1 - F10).

Before ***SOFTK*** definition, in the declaration section of PLC, it must be introduced the following instruction:

LANG, cod_lang_1[, cod_lang_2] [...] [, cod_lang_5]

where language codes may be:

1= **Italian**
2= **French**
3= **German**
4= **English**
5= **Spanish**
6= **Portuguese**

In the declaration of menus the label for each softkey must be specified together with microedit text in all the required languages following the declaration of ***LANG*** with the syntax shown:

Example:

Italian and English messages:

```
LANG,1,4
. . .
SOFTK,1
P01,L01,' volantino X ' ' handwheel X '
P02,L02,' tempo lubrif. ' ' lubrif. time ',' minuti= ' ' minuts= ', TIME
P03,L03,' parola chiave ' ' password ',' inserisci= ' ' insert= ', STR:CHIAVE, ' manutenzione ' ' service'
```

The variable ***SFKLNG*** (written from NC) contains the code indicating the active language on the NC.
By testing this variable it is possible to organizing the PLC program in order to initialize the string variables to display multilingual messages.
Language codes are the same of those used in the declaration of ***LANG***.

Example:

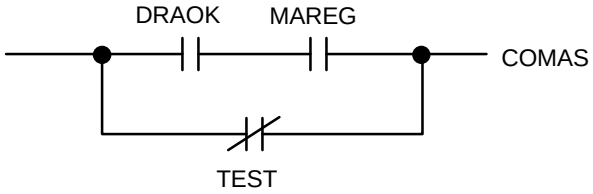
```
. . .
INIT
IF (SFKLNG<>1) ENGL
[Initialization Italian messages
MSG(1)=' EMERGENCY  STOP'
MSG(2)=' FAULT  ON  SPINDLE  DRIVE'
. . .
ENDMSG
[
ENGL : $
IF (SFKLNG<>4) ENDMSG
[Initialization English messages
MSG(1)=' EMERGENCY  STOP '
MSG(2)=' FAULT  ON  SPINDLE  DRIVE '
[
ENDMSG : $
. . .
```

5. FUNCTION AND OPERATION

5.1. PROGRAMMING WITH ELEMENTARY LOGIC

The first logical network encountered in any PLC application is a combination of closed and open contacts representing true or false signals that activate an output.

For example take the electrical schematic below:



To describe the function of the logic network shown above it can be said that the output COMAS is active when DRAOK and MAREG are true (closed) or TEST is false.

In PLC S3000 language this is written as:

COMAS=DRAOK&MAREG~"TEST

Where the elementary logic operators are:

& **AND**
~ **OR**
| **XOR**
" **NOT**

When applying the logic operators it is necessary to remember that AND and XOR have a higher priority than OR.

In the equation U=A~B&C it is evaluated as U=A~(B&C).

If instead it is desired to OR A with B and then AND the result with C, this is written as U=(A~B)&C

The parenthesis changes the priority of the operations, as in conventional arithmetic.

Logic operators may be applied to signals, bits, bytes, and words. Expressions are evaluated for bit to bit correspondence. Therefore the operands in the same equation must be of the same type.

Example:

```
RAM,16
CONFI(3)        [declares an array of 3  16 bit variables
TEMPOR          [tempory storage used for bit manipulation
...
PROG
[example to invert the 4th bit of the first element in the array CONFI()
TEMPOR=CONFI(1)
IF(TEMPOR(4)) TEMPOR(4)=0;CONFI(1)=CONFI(1)&TEMPOR;END  [reset bit 4
IF("TEMPOR(4)) TEMPOR(4)=1;CONFI(1)=CONFI(1)~TEMPOR         [set bit 4
END:$
...
```

5.2. ARITHMETIC OPERATIONS

May be applied to byte, word, double and long formats.

The typical syntax format is:
result=operand operator operand [...][operator operand]
possible operators are:

+	addition
-	subtraction
*	multiplication
/	division
//	division remainder

Example:

(10.5//7)=3.5

If this operation is made on bytes or words the result will be an integer remainder.

The // operation can be used to extract the decimal portion of a floating point number by dividing it by 1.0

Example:

(4.123//1.0)=0.123

Operators and parenthesis have the same priorities as in traditional arithmetic.

IMPORTANT: If the result of an operation results in a number greater than the size of the variable, it is converted to its 2's compliment.

The result of a division by 0 results in the maximum positive number for the variable.
If overflow, underflow, and division by 0 occur during program execution the system displays an appropriate error message (see *Part II - List of Preset Signal and Registers*).

5.3. FLOATING POINT MATHEMATICAL FUNCTIONS

The following functions may be used on single, double, and long formatted variables. Trigonometric functional units are degrees.

SQR	**(argument)**	square root
INT	**(argument)**	truncated integer
NEI	**(argument)**	rounded integer
SIN	**(argument)**	sine
COS	**(argument)**	cosine
TAN	**(argument)**	tangent
ATN	**(argument)**	arctangent
LOG	**(argument)**	logarithm
LGT	**(argument)**	logarithm base 10
ACS	**(argument)**	arccosine
ASN	**(argument)**	arcsine
NEG	**(argument)**	change sign
SGN	**(argument)**	substitutes a value in the format of the operand equal to 1 if the sign is positive and -1 if it is negative.
operand^operand		raise to a power
ABS	**(argument)**	supplies the absolute value of a byte, word, long or double formatted variable.

Note: in the case of raising to the power of 2, it is more efficient, in terms of execution speed, to use the syntax ***argument*argument*** instead of ***argument^argument.***

5.4. COMPARE

It is often necessary to compare two variables or a variable and a constant value and then operate on the result.

Comparisons may be made using the following symbols:

=	equal to
<>	not equal to
>	greater than
<	less than
<=	less than or equal to
>=	greater than or equal to

The comparison expression must be contained within parenthesis and may therefore be used as a logic element within an equation.

Example:

MAOR=(AUXM=3)~(AUXM=13) [MAOR is true when AUXM=3 or when AUXM=13

This function can be used for Bytes, Words, etc.. provided the equation is homogeneous.
It cannot be used for strings. To compare two strings the function ***STRCMP()*** must be used.

5.5. ROTATION

This function can be performed on byte and word variables - BIT, LONG, and DOUBLE formats are not allowed. The operand @ is used followed by the number of rotations to be effected.

variable@ + n effects a left Rotation
variable@ - n effects a right Rotation

where n, is the number of rotations in BYTE or WORD format.

A left rotation moves all of the bits in the direction of the most significant bit, while the most significant bit moves into the least significant bit location.. Right rotation performs the opposite function.

Example:

STATP = STATP @+1 effects a left rotation of one position per bit.

Before rotation	1	0	0	0	1	0	0	0
After rotation	0	0	0	1	0	0	0	1

5.6. FORMAT CONVERSIONS

Aset of functions are provided for converting an input variable to an output variable with a different format.

The syntax is the same for all functions:

output=function(argument)

where: ***argument*** may even be a complex expression.

ENC - search bit

Scans the ***argument*** value starting from the least significant BIT, and produces an output that indicates the position of the first bit that is set to a 1. The output is 1 to 16 if the argument is a WORD or 1 to 8 if it is a BYTE.

Example:

ENC (10100000B) = 6

DEC - Set bit

Outputs a BYTE or WORD with a 1 in the bit position corresponding to the value of the ***argument***, provided the value does not exceed 16 for words or 8 for bytes.

Example:

DEC (7) = 01000000B *since the number is 7, the seventh bit of the output word is set to a 1.*

HI - Extracts the high byte from a word

Converts the eight highest bits in the argument word into a byte (***argument***).

Example:

BYT1=HI(WORD1) *extracts the upper portion of WORD1*

LO - Extracts the low byte from a word

Converts the eight lowest bits in the argument word into a byte (***argument***).

Example:

BYT1=LO(WORD1) *extracts the lower portion of WORD1*

EXT - Conversion of a byte into a word

Extends a byte (***argument***) into a word with sign preservation. In other words, if the sign bit (bit 8) was 0 it adds eight zeroes to the left; if it was 1 it adds eight ones to the left.

Example:

WORD2=EXT(BYTE1)

BCD - Converts a binary number to BCD

Converts a byte (***argument***) into a two digit BCD number or a word(***argument***) into a 4 digit BCD number.

Example:

BCD1=BCD(BYTE1) if BYTE1 was equal to 00001100 (12 decimal), BCD1 would be 0001 0010

BIN - Converts a BCD number to a byte or word

Converts a two digit BCD number contained within a byte, or a 4 digit BCD number contained within a word back into binary format. Hence it is the opposite of **BCD**.

Example:

BYTE1=BIN(BCD1) if BCD1 was equal to 0001 0010, BYTE1 would be 00001100

IFP - Converts a byte or word into floating point format

This function is necessary for executing mathematical operations on bytes and words which are reserved for floating point variables.

Example:

NUTF=IFP(DTOOL) converts DTOOL variable into floating point

FPI - Converts floating point format into byte or word

5.6.1. COMPLEX EXPRESSIONS

The functions described above for the transformation between various formats may be used in conjunction with the arithmetical and mathematical functions to form complex expressions.

However, not all of the functions are useful in complex expressions. In particular the following complex expressions are not allowed.

- Functions with more than one argument:
  FF(..),(..), MUX(..),(..), RIC(..)

- Functions with string arguments:
  VAL(...), LEN(..), INSTR(..),STRCMP(..)

The following are examples of valid complex expressions

Example 1:

```
RAM,8
ANGLE
RAM,32
RESULT
...
RESULT=SIN(IFP(ANGLE*2+45))
```

the result of the expression ANGLE*2+45 is converted to floating point and then the sin of that value is taken.

Example 2:

POWER=OFFSET+SIN(1/FREQ*TIMBAS)+COS(ANGLE)

Power is equal to the sum of offset and the cosine of ANGLE plus the sine of the expression 1/FREQ*TIMBAS

5.7. STRING OPERATIONS

A string is an array of alphanumeric characters excluding commas.

5.7.1. NUMERICAL FUNCTIONS WITH STRING ARGUMENTS

These are functions resulting in a numerical value starting with a string arguments:

VAL - Transforms an ASCII format to a numerical value

Supplies the numerical value of a string variable. The syntax is:

VAL(argument)

where ***argument*** may be:

- a string variable
- an expression which results in a string variable

The output of this function may be in BYTE, WORD, LONG, or DOUBLE format. The output format selected must be compatible with the length of the string argument that is to be converted.

The conversion stops at the first non-numerical character.

Example:

```
RAM,32
NUMVAL
STR
NUMSTR
...
PROG
NUMSTR='123.56'
NUMVAL=VAL(NUMSTR)        [NUMVAL contains the numerical conversion of NUMSTR
                          [ which is NUMVAL=123.56
```

INSTR - Search for a string within a string

Searches for a string within another string, starting from a specified position and for a specified length. It supplies the position at which the first character of the string was found. The format is:

INSTR(argument1,argument2,argument3,argument 4)

where:

argument1 is the string within which the search takes place
argument2 is the string to be found
argument3 is the position from which to begin the search

argument4 specifies how many characters in argument 2 must be searched through starting from argument 3

argument1 and argument2 may be:
- a sequence of characters delimitated by inverted commas
- a string variable
- an expression whose result is a string

argument3 and argument4 may be:
- an integer between 1 and 255
- a byte variable with a value between 1 and 127 or a word variable with a value between 1 and 255
- an expression whose result is a word or byte with the same numerical limits as those above.

The value assigned by the function may be a byte or word.

The function may yield different results based upon the values of ***arguments 1-4*** and other conditions as indicated below:

- if the string is not found a 0 is substituted for the result.
- if ***argument2*** is a null string ***argument3*** is returned
- if ***argument1*** is a null string a zero value is returned
- if ***argument3+argument4*** is greater than the length of ***argument1***, the search begins from ***argument 3*** and continues until there are no more characters left.
- if ***argument4*** is less than or equal to 0, the result will be zero

Example:

Suppose that VARIAB1 contains 'ABCDEABCUPABCXY' and VARIAB2 contains 'AB', and the instruction used is:

POSIZ=INSTR(VARIAB1,VARIAB2,4,13)

the result obtained in POSIZ is the number 6)

LEN - String length

Supplies the number of characters including spaces of the argument string, The format is:

LEN(argument)

where the ***argument*** may be:
- a string variable
- an expression whose result is a string variable

The output of this function may be in byte or word format.

Example:

```
RAM,8
LUNST
STR
MSG1
...
PROG
MSG1='ALARM NUMBER3"
```

LUNST=LEN(MSG1) [LUNST contains the number of characters in MSG1

STRCMP - String comparisons

compares two arguments specified by the operator and supplies a result of true or false. The two arguments may take different formats. The format is:

STRCMP(argument1 operator argument2)

the ***operator*** may be <,>,<=,>=,=,<>

argument1 and ***argument2*** may be:

- a sequence of characters delimitated by inverted commas
- a string variable
- an expression whose result is a string

The result is in bit format and is obtained according to the following rules.

argument1>argument2 If the ASCII code, starting from the first character to last, is larger in argument1 than its counterpart in argument2. The result will be true.

Example:

STRCMP('COSE'>'COSA') [result is true

argument1>argument2 If the preceding condition is not true and the length of argument1 is greater than the length of argument2

Example:

STRCMP('COSE'>'CO') [the result is true

argument1=argument2 If all characters in both arguments are identical (including blanks)

Example:

```
RAM,1
TEST
...
PROG
TEST=STRCMP('AVARIA'='AVARIA')    [result; TEST=1
TEST=STRCMP('AVARIA'='AVARIA ')   [result: TEST=0
```

5.7.2. STRING FUNCTIONS ON NUMERICAL ARGUMENTS

The result of these functions are strings of characters whose formats can be a string of any length.

MKN$ - converts a number into string format

Converts any number in any format except bit format into a string of ASCII characters

S1200 In PLC programs for the S1200 system the ***ASC(argument)*** function was used.

This function may be used, for example, to display the value of a numerical variable as a message. The output of the function must be assigned to a string variable. The format is:

MKN$(argument)

where the ***argument*** may be:
- an explicit number
- a variable
- the numerical result of an expression

If the ***argument*** is in byte format, the result of the conversion has 4 characters, the first of which is the sign or blank, and the three others are either 0 or a number.

For example:
the conversion of a byte containing the value 1 would be '001'
the conversion of a byte containing the value -11 would be '-011'

If the argument is in word format, the result of the conversion would be 6 characters, the first of which is the sign or blank, and the five others are 0 or a number.

For example:
the conversion of a word containing the value 1 would be '00001'
the conversion of a word containing the value -11 would be '-00011'

Example:

MSG4=MSG5+MKN$(SS0) [*if MSG5 contains the 'tool number' and SSO a byte of value*
[*12; the function would result in 'tool number 012'*

CHR$ - Generates an ASCII character

Outputs the ASCII character correspondint to the ASCII code specified in the function's argument (see ASCII code Table at the end of the manual).The format is:

CHR$(argument)

where ***argument*** may be:
- a whole number between 0 and 255
- a word or byte variable with a value between 0 and 255
- an expression whose result is a word or byte variable with a value between 0 and 255

The result of the function must be assigned to a string variable.

Example:

```
LETTER=CHR$(035)          [LETTER will contain the character #
```

STRNG$ - Generates a string of equivalent characters

Generates a string of identical characters for a specified ASCII code. The format is:

STRNG$(argument1,argument2)

where:
argument1 is the ASCII code of the character in the string
argument2 is the number of characters to be generated

argument1 and argument2 may be:
- an explicit integer between 1 and 255
- a byte or word variable with a value between 1 and 255
- an expression whose result is either a byte or word variable with a value between 1 and 255

If ***argument2*** is greater than the format of the assigned variable it will be truncated.

Example:

```
STR
MSG
RAM,8
NUMCAR
CODCAR
PROG
NUMCAR=20                       [length of string to generate
CODCAR=42                       [ASCII code for an asterisk (*)
MSG=STRNG$(CODCAR,NUMCAR)       [generates a string of 20 asterisks
```

5.7.3. STRING FUNCTIONS WITH STRING ARGUMENTS

MID$ - Extracts a small string from a larger string.

Extracts a specified number of characters from the string starting from a specified position.

MID$(argument1, argument2, argument3)

where:
argument1 is the string to draw from
argument2 is the position of the character where the extraction starts
argument3 indicates the number of characters to be extracted

argument1 may be :
- a string variable

argument2 and ***argument3*** may be:
- an explicit integer between 1 and 254
- a byte variable with a value between 1 and 127 or word variable with a value between 1 and 254
- an expression whose result is a word or byte as described above.

The output of the function must be assigned to a string variable. The following rules apply:

- If ***argument2*** is longer than ***argument1*** the result is an empty string
- If ***argument3+argument 2*** is longer than ***argument1*** the extraction is made until there are no more characters available
- If the length of ***argument1*** is 0, the result is an empty string

Example:

Suppose that VARIAB1 contains the string 'ABCDEFGHLMN'

VARIAB2=MID$(VARIAB1,4,5) VARIAB2 becomes the string 'DEFGH'

LEFT$ - Extracts a string starting from the left

Extracts a specified number of characters from a string starting from the beginning of that string. The format is:

LEFT$(argument1, argument2)

where:
argument1 is the string from which to extract
argument 2 is the number of characters to be extracted

where ***argument1*** may be:
- a string variable

where ***argument2*** may be:
- a whole number between 1 and the length of the string
- a BYTE or WORD variable with a value between 1 and the length of the string
- an expression whose result in a BYTE or WORD variable with a value between 1 and the length of the string.

The output of the function must be assigned to a string variable. The following rules apply:

If ***argument2*** is longer than ***argument1***, all available characters are extracted

If the length of ***argument1*** is 0, the result is an empty string

RIGHT$ - Extracts a string starting from the right

Extracts a specified number of characters starting from the last character in the string. The format is:

RIGHT$(argument1, argument2)

where:
argument1 is the string from which to extract the characters
argument2 is the number of characters to be extracted

argument1 may be:
- a string variable

argument2 may be:
- a whole number between 1 and the length of the string
- a BYTE or WORD variable with a value between 1 and the length of the string
- an expression whose result is a BYTE or WORD variable with a value between 1 and the length of the string

The function output must be assigned to a string variable. The following rules apply:

If ***argument2*** is longer than ***argument1***, all available characters are extracted

If the length of ***argument1*** is 0, the result is an empty string

5.7.4. COMBINING STRINGS

Strings can be appended to each other to form a new combined string.

The syntax is:

name=argument1[+..][+argumentN]

where ***argument1*** and ***argumentN*** may be:
- a sequence of alphanumeric characters delimitated by inverted commas
- a string variable
- an expression whose result is a string

Example:

```
RAM,32
IPERC
STR
MSG(10)
PROG
MSG(10)='ABSORBED CURRENT'
MSG(1)=MSG(10)+MKN$(IPERC)+'AMPERE'    [the value of the current, IPERC is inserted in
                                        [the string
```

6. INSTRUCTIONS FOR PROGRAM FLOW CONTROL

A LABEL is the name given to a program line which is to be called by a subroutine or jump statement.

Labels can be identified by the use of the "**:**" after the expression.

Program flow can be controlled with the following instructions:

- UNCONDITIONAL JUMP
- CONDITIONAL JUMP
- CONDITIONAL EXECUTION
- CALCULATED GOTO
- QUESTIONED GOTO
- LOOP
- SUBROUTINE

6.1. UNCONDITIONAL JUMP

The format is as follows:

labelx *the program jumps to the point* ***labelx****:*
...
labelx:...

where:
labelx is the jump instruction
labelx: is the label to jump to

Note: The unconditional jump has a format (***labelx...labelx***:) similar to (***name1:name2***) for equivalence declaration (see chapter 4.4 for *Equivalence Declaration*). The substantial difference consists in the fact that the declaration of equivalence is used only in the initial declaration section, whereas the jumps are used in other parts of the program.

6.2. CONDITIONAL JUMP

The format is as follows:

IF(equation or signal)labelx
...
labelx:

If the equation or signal is true (high), the program will jump to the **labelx**, else it will continue with the next line.

Example:

IF(“BURDY)ASINC
...
ASINC:...

6.3. CONDITIONAL EXECUTION

The minimum format is:

IF(condition)equation

The equation after the parenthesis is executed only if the condition is true.

A more complex syntax is as follows:

IF(condition) equation[;...] [;equation] : ELSE equation[;...] [;equation]

the first equation is executed if the condition is true, otherwise the equations after the ***ELSE*** are executed; the whole expression must fit on one line.

If the expression cannot fit on one line, it can be extended to another line by use of the ***$*** symbol; the final limitation is that the expression stays under 500 characters excluding blanks.

Example:

IF(VEMA>=1) VEMA=.9999;LIMIT=1$ [example of the use of the $
:ELSE LIMIT=0

It is not possible to have more than one ***IF*** instruction nested on the same line.

6.4. CALCULATED GOTO

To allow for free movement within the program this instruction jumps the program to labels declared within numerical functions or expressions.

the format is as follows:

GOTC(expression) label1 [,label2] [,..] [,label255]

where ***expression*** may be:
- a BYTE or WORD with a value between 1 and 255
- an expression which results in a BYTE or WORD with a value between 1 and 255

The maximum number of LABELS is 255. If the space on one line is not sufficient, additional lines may be added by using the $ end of line marker. The final limitation is that the number of characters may not exceed 500 excluding blanks.

Example:

```
RAM,8
NLAB
PROG
NLAB=...                        current label to jump to
GOTC(NLAB)L1,L2,L3,LEND
LEND
...
L1...
...
LEND
L2...
...
LEND
L3...
...
LEND...
```

The system calculates the expression and uses the results to select the label to jump to.

If the value of the expression is 0 or the label cannot be found, the program continues with the next instruction.

6.5. QUESTIONED GO TO

Permits system to jump to a label depending on which bit is set in a variable.
The format is as follows:

GOTP(expression) label1 [,label2] [,..] [,label16]

where:
expression may be:
- a BYTE or WORD with a value between 1 and 16
- an expression which results in a BYTE or WORD with a value between 1 and 16.

The ***expression*** is evaluated to find the position of the first bit that is set to one order number of the label to be jumped to. Execution then jumps to the label that corresponds to the set bit's location.

```
BIT 1 first label
BIT 2 second label
...
BIT 16 sixteenth label
```

The maximum possible number of labels is 16.

If the expression contains more than one bit set to 1, the least significant one is selected.

If the expression is equal to 0, the next block is executed.

Example:

```
RAM,16
SELECT
PROG
SELECT=0000000000000100B
GOTP(SELECT)FAS1,FAS2,FAS3        the execution passes to LABEL FAS3
```

6.6. LOOP

The format is:

EXEC=expression
...
ENDE

where ***expression*** may be:
- a whole number between 1 and 255
- a BYTE or WORD with a value between 1 and 256
- an expression which results in a BYTE or WORD with a value between 1 and 256

The instructions falling between ***EXEC*** and ***ENDE*** are executed as many times as is defined by the expression.

Up to four nested loops are possible

Example:

```
I=0
EXEC=(2*XTAB)          [zeros the table TAB
I=I+1
TAB(I)=0
ENDE
```

6.7. SUBROUTINE

To call a subroutine; the instruction ***CALL*** is used, followed by the name of the subroutine desired.

The last instruction of a subroutine must be ***RTS*** to return.

A subroutine is called conditionally if the ***CALL*** instruction is preceded by an ***IF (...)*** statement in the same expression.

Example:

IF(STROM) CALL GEFUM

If a subroutine is written within a (fast, slow, superslow) logic section, it may be called only from within that section.

Writing the subroutines instead in the reserved ROUTINE section at the end of the program, it is possible to call them from different parts of the program.

It is possible to nest subroutine calls up to 8 levels.

7. SPECIAL FUNCTIONS

This chapter describes certain functions which have not been described in earlier chapters, and which may be used to activate machine signals, for searching vector variables, for managing the user interface, and finally for the management of commands generated by the machine logic program (PLC) and sent to the NC.

7.1. FLIP FLOP

This function can be generated using the following instruction format:

Output=FF(set equation),(reset equation)

The output variable assumes the following values as a function of the input values:

Set equation	Reset equation	Output signal	Note
0	0	x	output does not change
0	1	0	
1	0	1	
1	1	0	reset has priority

Example:

REME = FF(OLTREC ~ TERMIC),(EMEA)

7.2. MULTIPLEXER

Assigns a value to a variable by selection from a list of variables or constants using bit variables to control the selections.

The syntax is as follows:

varout = MUX (sel1, sel2 [, sel3][, sel4] [, ...]),(var1, var2 [, var3] [, var4] [, ...])

where:

sel1, sel2, sel3, sel4, are selection control variables in BIT format or expressions resulting in true or false

var1, var2, var3, var4, are BYTE, WORD, LONG or DOUBLE formatted just as ***varout***.

The list of selection control bit variables is scanned to find the first variable that has a bit value of 1. The corresponding variable in the second list is then selected as ***varout.***

The function may operate upon a maximum of 16 variables.

If no selection variable is active (high), the value of ***varout*** remains unchanged.

Example:

MULTI1=MUX(SELEZ1,SELEZ2,SELEZ3),(VARIA1,VARIA2,VARIA3)

7.3. TABLE SEARCH

This function returns the vectorial position of a value searched for in a table. If the search value is not found, the program branches to the specified label.

The format is as follows:

position=RIC(table,first index, last index, value to be searched)label

where:

- ***position*** is the table position where the searched value is found
- ***table*** is the name of the table containing the value to be searched
- ***first and last index*** indicate the search interval. To search the whole table the first index =1, and the last index = table dimension
- ***search value*** the value to be searched for
- ***label*** the instruction for the program to jump to if the search value is not found

position may be a BYTE or WORD variable
table may be a BYTE or WORD vector
first index, last index, and search value may be:
- a whole number between 1 and 32767
- a BYTE or WORD value between 1 and 32767
- an expression resulting in a BYTE or WORD value between 1 and 32767

Vector tables created in the PLC can be displayed and modified by the user following the methods outlined in chapter 2.6 (Display and Modification of PLC tables).

Example:

POMAG=RIC(TABUT,1,25,NEWTOL*2)ERRCU [*searches for a new tool in the table TABUT*

7.4. MESSAGES FOR THE OPERATOR

The display screen provides 16 lines for messages of up to 62 characters each. They may be accessed by the softkey ***LOGIC MESSAGES***.

To display a message the command ***DISPL*** is used followed by the line number and the message desired.

The message remains displayed until it is cancelled by the command ***CLR,*** or when it is overwritten.

To recall a message during the course of a program the display command must be used. The syntax is:

DISPL, line number, message

where:

line number may be:
- an integer between 1 and 16, or 0 to display a message in the reserved area of the NC's display monitor.
- a BYTE or WORD variable with a value between 0 and 16
- an expression whose result is a BYTE or WORD variable with a value between 0 and 16

message may be:
- a sequence of characters delimitated by inverted commas
- a string variable
- an expression which results in a string

Messages may also be obtained by combining predefined messages
with strings obtained using the ***MKN$(...)***function.

Example:

```
STR
MESDI
MESSAG
...
PROG
MESSAG='CYCLE STOP DUE TO ANOMALIES IN' +MESDI+MKN$(NUM)
DISPL,1,MESSAG
```

In the example the message is defined by the first expression, MESSAG and displayed on line 1.

If MESDI='MOVEMENT OF AXIS N' and NUM=2; the phrase appearing on line 1 of the display is:

CYCLE STOP DUE TO ANOMALIES IN MOVEMENT OF AXIS No2

If the ASCII text is changed in MESDI or a vector is substituted such as MESDI(n), the same instruction could yield the following messages:

CYCLE STOP DUE TO ANOMALIES IN PUMP No1
CYCLE STOP DUE TO ANOMALIES IN PALLET POSITION No4

messages can be cleared using the following command:

CLR,line

where ***line*** may be:
- an integer between 0 and 16
- a BYTE or WORD with a value between 0 and 16
- an expression resulting in a BYTE or WORD with a value between 0 and 16

Since message texts, such as MESDI in the previous example are usually constants it is best to declare them in the initialization section. Alternatively the message can be defined within the ***DISPL*** instruction at the point of use.

Example:

DISPL,1,'LUBRICATION PRESSURE ANOMALY'

NOTE:

In the third part of this manual (*PLC Program examples*), a program is described called *SCROLLIN (- management of up to 128 messages using display scrolling*), which automatically compacts many messages on the 16 available lines, scrolling through all available messages until the one desired is found.

7.5. MACHINE LOGIC PROGRAM COMMANDS

Sometimes it is more efficient to use a program written in the PLC language to manage the function of a tool change or a part change that requires complex sequences or axis movements.

The machine logic can activate these desired commands by accessing the NC program through the "EDITCOM" (see the *System Configuration Manual*):

COM,1,program name

where:

program name may be:
- a sequence of characters delimitated by ‘ ‘
- a string variable
- an expression whose result is a string

S1200 Unlike the S3000, in the S1200 system it is not possible to run a sub program contained within a program and identified by a label. Programs run with the COM functions however may contain any NC executable block, including jumps, measure cycles and PROGET2 advanced geometry.

S1200 False positioning of parameters ***P1...P99*** is no longer possible as it was with the S1200 where P0 = P(1)

The programs called by ***COM*** may use the specific ***P*** parameters ***P1..P99***. These parameters are independent from the part program parameters and are directly accessible by the PLC writing the ***P*** variables on the elements from ***P(1)*** to ***P(99).***

When a ***COM*** command is run the coordinate system functions are automatically reset (origin displacement, fixed cycles, rotary translation, ...)

The FEED and SPEED values can be saved in the ***P()*** parameters (example : P(1)=F) and later restored using the inverse instruction F=P(1).

Particular care must be taken to use the ***COM*** instruction to run a given program only once or else the possibility of error due to nested sub-programs may result.

7.5.1. PROGRAM COMMANDS USED DURING AUTOMATIC PROGRAM EXECUTION

The ***COM*** instructions to be implemented during automatic program execution must be synchronized with the program and follow the ***T*** or ***M*** functions at the end of a block (*see part II - List of predefined registers and signals*). The implementation must be:

- before the BURDY signal is reset
- or with DHOLD high. The COM instruction must be completed before the BURDY signal is reset.

See the paragraph in Part II of this manual describing the system interface (*Acquisition of synchronous data from the PLC to the NC*).

A program started by an auxiliary function may contain functions which call other programs (but not itself) up to 8 nested levels are allowed.

When all of the programs run by the ***COM*** are completed the ***STCOM*** synchronous strobe is set by the NC before returning to the next main program block (as long as the ***BURDY*** signal is high).

This strobe is similar to an end of block ***M*** or ***T*** function for synchronization. It allows the execution of other COM instructions using the methods described above.

7.5.2. PROGRAM COMMANDS RUN FROM THE MANUAL MODE

COM programs may be run from manual mode using the **NCMD=5** (asynchronous mode) function.

The syntax is the same as that described at the beginning of the chapter, however, the program is not synchronized with the ***BURDY*** signal.

The ***STCOM*** strobe is not activated at the end of this type of ***COM.***

Inside an "asynchronous ***COM***" it is possible to insert a function which calls a synchronous ***COM*** following all of the rules described in the preceding paragraph.

To run this type of ***COM*** instruction the axes must be stationary. To confirm this condition an axis stopped signal may be provided by the equation:

bit ASI FERMI=(("INTOL&MOVCN)=0)

Example:

In the following example the program PALLETS is called from the machine logic program using a ***COM*** instruction following the ***M21*** function and with ***BURDY*** high, ie. in synchronous mode:

```
...
IF("BURDY)ASINC
DHOLD=1;FHOLD=1
IF(STROM)CALL GEFUM
BURDY=0
ASINC;$
...
END
...
GEFUM:$
IF(AUXM=21)COM,1,'PALLETS';RTS
RTS
```

7.5.3. MACHINE LOGIC PROGRAM COMMANDS IN SEMIAUTOMATIC MODE RUN

The COM partprogram subprograms run from the PLC are executed in automatic (no wait for the «start cycle» between one block and the next) even if the NC is executing a machining program in semiautomatic.
The variable **NCMD** though, still remains consistent with the NC's execution status.

The following modal functions for piece programming permit alteration of this:

- ***G1011***: forces execution of the COM subprograms in semiautomatic when the status of the NC is semiautomatic (to be used in checking or tuning).

- ***G1010***: disables the operation activated with G1011 (restores the default condition).

MACHINE LOGIC PROGRAM COMMANDS: UNIT OF MEASURE

The movement blocks executed inside the COM subprograms run from the PLC are always interpreted in millimetres, even if the NC has been set to work with the measurement system in inches.
When execution of the COM is complete, the system in use before running of the subprogram is restored (inches or millimetres).

MACHINE LOGIC PROGRAM COMMANDS: FUNCTIONS NOT PERMITTED

The running of a COM subprogram signals error "**E48**: opening/closing functions missing" when certain functions are active which alter the system of coordinates (***G846***, ***G851***, ***G68***, ***G69***, fixed cycles, fixed supercycles, ***G751***, ***G16***, ***G748***, ***G749***).
Other functions (***G52***, ***G51***, ***G54***, ***G55***, ***G56***, ***G57***, ***G58***, ***G59***, ***G61***, ***G76***) are, on the other hand, disabled temporarily when the COM is run and are restored when it is completed.

MACHINE LOGIC PROGRAM COMMANDS:RUNNING IN ASYNCHRONOUS MODE

The PLC can request running of a COM subprogram even asynchronously with respect to the program being executed.
This feature can, for example, be used to manage a tool change sequence in case of expiry of tool life.
Whenever the PLC wants to run the asynchronous COM, it must set the bit **RCOM**; after this request, the NC finishes the precalculated program blocks (max. 256), then sets in synchronous mode (accompanied by the signal **BURDY**) the strobe **STRCOM**.
The PLC must decode this strobe and then execute the COM instruction, ...which in this way is synchronized with the main program.
RCOM is reset immediately upon being acquired by the NC.

In the case of axis groups, there are the bytes **RCOM_** and **STRCO_** in which each bit corresponds to an axis group.

Name	*Size*	*Direction*	*Synchronous*	*Description*
RCOM	1	PLC ⇒ NC	no	Request to activate an asynchronous COM.
STRCOM	1	NC ⇒ PLC	yes	Synchronization strobe for running of the COM requested with RCOM.
RCOM_	8	PLC ⇒ NC	no	Requests to activate asynchronous COMs for the individual axis groups (1..8).
STRCO_	8	NC ⇒ PLC	yes	Synchronization strobe for running of the COM requested with RCOM_ for the individual axisgroups (1..8).

PART II

SYSTEM INTERFACE

INTRODUCTION

The information found in this section concerns the interchange variables and signals used between the PLC (Programmable Logic Controller) section and the NC (Numerical Control) section of S3000 controls. This information is valid for the following modules:

- The Standard module, which deals with the management of movements and of the various operating modes and screen displays

- Internal dedicated modules which are:

- Spindle management module
- Module for handling independent axes
- Module for managing the tool change

Descriptions of the information mentioned above is organized as follows:

At the beginning of each operation, whether of the standard or dedicated modules, the various registers, variables, signals and their interaction are described. A table follows each description which summarizes the signals described, along with their unique characteristics (see below). In turn, these tables are found in Part 4 of this section as a handy reference for use during application development.

For each subject area, the tables state the following characteristics for each register, variable or signal:

- The mnemonic name

- The format (in the **Dim** column)
  1 = bit
  8 = byte
  16 = word
  32 = floating point
  64 = double floating point
  STR = character string

- The synchronous constraints with the signal ***BURDY*** (in the **Syn** column)
- The information directions: from PLC to NC, vice versa or in both directions (in the **Direction** column).

Note: Writing to PLC read-only variables, with the direction from the NC to the PLC and not vice versa, can have unpredictable consequences.

- A brief **Description** in the corresponding column.

The **units of measure** used are the following:

- for measurement of heights**,** distances, adjustment settings mm
- for rotative dimensions degrees
- for timing msec, sec or min
- for speed: mm/min
- for acceleration: mm/(sec²)
- for spindle speed revolutions/min
- for voltage V

The **symbology** used are the following:

The character ***()*** after the name of a register indicates there is a multi-element vector in the specified format (for example, ***UTNUM()***, while ***MOVCN*** is a single register).

Whenever the symbol ***(1..n)*** appears following a listed item, the register or the vector must be interpreted by individually analyzing the elements from (1 to n). In order to determine a single register whose bits are described, it must be kept in mind that:

- The dimension of vector elements is greater than 1.
- When single register bits are described, these descriptions are generally preceded by the description of the register itself, which will be indicated without parentheses.

Example:

Name	Dim	Direction	Syn	Description
MOVCN	8	NC ⇨ PLC	no	Request axes enable (1..8).
MOVCN(1)	1	NC ⇨ PLC	no	(first bit of the byte) request for axis 1
MOVCN(8)	1	NC ⇨ PLC	no	(eighth bit of the byte) request for axis 8
UTNUM()	16	NC ⇔ PLC	no	Code of tool in table (1 ... ***UTENRI***), where ***UTENRI*** represents the number of lines in the tool table.
UTNUM(1)	16	NC ⇔ PLC	no	(first element of the word vector) the tool code present in line 1 of the tool table.
UTNUM(8)	16	NC ⇔ PLC	no	(eighth element of the word vector) the tool code present in line 8 of the tool table.

Note: For optimal legibility, the above column headings are not reprinted above the tables shown throughout this text. Therefore, please note that the information is consistently listed according to the column headings in the table above.

1. SIGNAL FLOW AND DATA EXCHANGE

1.1. NC STATUS

The Numerical Control system signals its status to the PLC using two signals ***NCMD*** for the operating status and ***STBMD*** as status change strobe signal.

NCMD can assume the following values:

1 coordinate reading
2 single block
3 semiautomatic program execution
4 automatic program execution
5 manual
8 reset to default values
9 manual active in hold state

Assigning to the ***FNCMD*** register the value of 3, the NC is forced in a semiautomatic program execution status (***NCMD***=3). In normal conditions the ***FNCMD*** value must be zero and 3 is the only assignable value different from zero.

Summary of Registers and Signals Involved

NCMD	8	NC ⇨ PLC no	NC operating status code: 1 = coordinate reading 2 = single block 3 = semiautomatic program execution 4 = automatic program execution 5 = manual 8 = reset to default values 9 = manual active in hold state.
STBMD	1	NC ⇨ PLC no	Strobe pulse signaling change in NC status; having a duration of one slow logic cycle.
FNCMD	8	CN ⇦ PLC no	NC forcing register in semiautomatic execution

1.2. AUXILIARY SYNCHRONOUS AND PREPARATORY FUNCTIONS

The presence in the program blocks of an auxiliary function ***M, S, T, H*** performed individually (in single block status) or in the interior of a program (in automatic or semiautomatic status), is signaled to the PLC by means of communication registers and signals. These communication signals are *synchronized with the blocks themselves* and for the sake of brevity will simply be referred to as "synchronous" signals.

The primary synchronous signal is ***BURDY*** (BUffer ReaDY). It is set by the NC to signal to the PLC that there is a new auxiliary function.

The code of the new function is stored in the registers ***AUXM, SPEED, TOOL*** and ***AUXH***.

In addition, in order to optimize communication the NC sets a strobe signal that indicates which type of function is present. It will therefore have, respectively; ***STROM, STROS, STROT*** and ***STROH.***

Note: After decoding these signals to determine the new function, the PLC must immediately reset the ***BURDY*** signal so that the NC can continue working. ***BURDY*** must be used exclusively for the decoding of the auxiliary functions and not to stop the advancement of the blocks. Other signals are reserved for this purpose.

The strobes are signals updated by the NC only when ***BURDY*** is set. Therefore, they do not have a fixed duration, must not be reset by the PLC and are used only when the ***BURDY*** signal is active.

The decoding of the auxiliary functions is managed only in the SLOW SECTION of the PLC.

Since the auxiliary functions can written at the beginning and end of the program block (see the table at the end of the manual) it is important to assure that the strobe signals are decoded in the correct sequence.

In contrast, the preparatory functions ***G*** and ***F***, available on registers ***AUXG*** and ***FEED***, are not transmitted with the ***BURDY*** signal and are therefore, completely asynchronous with respect to the execution of the blocks. Another register, ***CICFI*****,** is also available which contains the fixed execution cycle code.

M, H auxiliary functions are selective and can operate only on certain axes. For example, the programming format to be decoded will be M11XYZ. In such cases the axes present in the block will be written in the ***AXPGM*** variable. The code in the example will be 00000111B. This feature will not be enabled for those axes whose motion has been requested in a block. For example, M11X100R will be written as ***AXPGM***=00000000B).

Example showing how new information is decoded and the BURDY signal is managed:

```
...
PROG
...
END
[slow section
IF("BURDY) ASINC                    [If  BURDY is not present jump to the   [asynchronous
part
DHOLD=1; FHOLD=1                    [Temporary stop
IF(STROT) CALL GEFUT                [T function management
IF(STROS) CALL GEFUS                [S function management
IF(STROH) CALL GEFUH                [H function management
IF(STROM) CALL GEFUM                [M function management
IF(STCOM) ...                       [All COM terminated
BURDY=0                             [New functions acquired
ASINC:$                             [Operations related to jump
...
DHOLD=...                           [Confirmation of data hold or release
FHOLD=...
```

```
END
...
END
[routines section
GEFUM:$
IF(AUXM=3) ...; RTS
IF(AUXM =11) M11
...
RTS
M11:$
IF(AXPGM=0) SSA=00000111B; RTS; ELSE SSA=AXPGM; RTS     [M11 management
...
```

1.2.1. ACQUISITION OF PLC TO NC SYNCHRONOUS INFORMATION

After the ***BURDY*** signal has been set to1 by a block or a series of blocks containing motion end codes, it is possible to acquire all the synchronous information sent by the PLC to the NC and referred to calls for subprograms from logic, active tool compensation etc., indicated in the summary list of previously defined variables (***INTOF, COM*** instructions - see paragraphs).

This same information can also be acquired when the ***DHOLD*** signal is active, i.e. when it is set before resetting ***BURDY*** and after an ***M*** function; block end or block start if programmed alone.

1.2.2. SIGNALING COM SUBPROGRAM TERMINATION

In synchronous mode the termination of a subprogram run by the PLC (COM) is signaled by NC through the ***STCOM*** strobe. This signal works in the same way as the ***STROM*** and ***STROH*** strobes but in addition, when set. It activates the synchronous acquisition of further subprogram calls as described in the preceding paragraph.

It is important to remember that:

- In the case of additional nested subprograms (a subprogram containing a function that, in turn, launches another subprogram), ***STCOM*** is issued only when the primary subprogram is terminated
- In the case of subprograms run with the NC in manual status, ***STCOM*** is not issued

1.2.3. SUPPLEMENTARY PARAMETERS I, J, K, Q

The parameters **I, J, K, Q**, which are programmed along with the auxiliary functions M, H, are communicated to the PLC at the beginning of the block on the ***AUXVAL*** array accompanied by the ***STRAUX*** strobes with the following indices. These can be used, for example, to define M19 Q12.2. type syntax.

AUXVAL(1) = parameter I with the strobe ***STRAUX(1)***
AUXVAL(2) = parameter J with the strobe ***STRAUX(2)***
AUXVAL(3) = parameter K with the strobe ***STRAUX(3)***
AUXVAL(4) = parameter Q with the strobe ***STRAUX(4)***

1.2.4. EXECUTION OF AUXILIARY FUNCTIONS "ON THE FLY"

Auxiliary functions (see table at the end of the manual) can be executed immediately during a continuous movement block with no axis deceleration, if programmed into the movement block itself.

Example:

```
N1 X100F1000
N2 X200F2000M7      [M7 executed immediately with X axis at 200 and a feed of 1000 mm/min.
N3 X300
N4 X400M9           [M9 executed immediately at X400 and steady feed
N5 [X450
```

Summary of Registers and Signals Involved

BURDY	1	NC ⇔ PLC	yes	Indicates that the NC has sent new synchronous data for the machine logic to decode.
AUXM	16	NC ⇨ PLC	yes	Last M code programmed (M0-M9999).
STROM	1	NC ⇨ PLC	yes	M function strobe present.
TOOL	16	NC ⇨ PLC	yes	Last T code programmed (T0-T32767).
STROT	1	NC ⇨ PLC	yes	T function strobe present.
AUXH	16	NC ⇨ PLC	yes	Last H code programmed (H0-H9999).
STROH	1	NC ⇨ PLC	yes	H function strobe present.
SPEED	32	NC ⇨ PLC	yes	Last S code programmed (S0-S99999).
STROS	1	NC ⇨ PLC	yes	S function strobe present.
STCOM	1	NC ⇨ PLC	yes	Strobe signaling end of execution of COM subprogram.
FEED	64	NC ⇨ PLC	no	Last feed programmed.
AUXG	16	NC ⇨ PLC	no	Last G code programmed (G0-G9999).
CICFI	16	NC ⇨ PLC	no	Fixed cycle in progress.
AXPGM	8	NC ⇨ PLC	yes	Axes with names programmed in same block as auxilliary function (ex. M11XYZ generates AXPGM=00000111B).
AUXVAL()	64	NC ⇨ PLC	yes	Array in which parameters I, J, K, Q are transmitted along with auxiliary functions M, H. ***AUXVAL(1)*** = parameter I ***AUXVAL(2)*** = parameter J ***AUXVAL(3)*** = parameter K ***AUXVAL(4)*** = parameter Q
STRAUX	8	NC ⇨ PLC	yes	Strobes for parameters I, J, K, Q. ***STRAUX(1)*** = strobe I ***STRAUX(2)*** = strobe J ***STRAUX(3)*** = strobe K ***STRAUX(4)*** = strobe Q

AUXILIARY FUNCTIONS: NOTES ON SENDING THE SPEED

At the end of a simulated program execution (pressing the softkey ***SEARCH END***), following a RESUME CYCLE or STORED SEARCH sequence, a block containing the last S encountered in simulation is sent to the PLC automatically.

1.3. ASYNCHRONOUS START, STOP, ALARM AND ACKNOWLEDGE CONTROLS

This group of signals allows the PLC to temporarily or permanently stop the activity in progress on the NC *without affecting the spindles, independent axes under PLC control or the tool change routine.*

With these signals activated NC status transitions are inhibited (ex: From manual to single block).

FHOLD (Feed Hold): This signal permits the temporary suspension of movements in progress by halting the axes, using the current programmed deceleration. When released the program continues without any further commands.

DHOLD (Data Hold): by setting this signal the PLC can temporarily halt the processing of subsequent program blocks. This does not take effect until the program reaches a point where the axes are stationary. When released the program continues without any further commands.

It is very important to remember that a profile of continuous interpolation or a series of movements without interpolation of auxiliary functions is considered to be a unique block.

RHOLD (Hold Request). This signal duplicates the red Hold key on the NC keyboard. Temporarily suspending any movement by stopping the program in progress, while not affecting movements on manual. In response, when the axes are stationary the signal ***HOLDA*** (Hold Acquired) is sent by the NC to signal the presence of the HOLD state. When the HOLD request is released program execution will not restart until the start cycle comand is given with the ***CYST*** signal or the Start key is pushed.

CYST (Start Cycle). The PLC signal duplicating the green Start key on the NC keyboard in order to provide a START control cycle.

SFKGRD (Guard): this variable is set (in binary code 11111111B, in hexadecimal 0FFH) pushing the "guard" key ❑ (on the left side of the space bar) and is reset (00000000B, 00H) releasing the key.

SFKCNS(1) Pulse signal which records the pushing of the green key Start on the NC keyboard.

SFKCNS(2) Pulse signal which records the pushing of the red key Hold on the NC keyboard.

SFKCNS(3) Pulse signal which records the pushing of the yellow key Break on the NC keyboard.

CYON (Cycle On). The signal provided by the NC to the PLC to inform it that the execution of a block is in progress.

REME (Emergency Request). This signal permits the PLC to make an external emergency request to which the NC responds by setting the ***EMEA*** signal (Acknowledge) to indicate the presence of the emergency state.

In this state the controlled axes are instantaneously disabled and the velocity commands forced to 0 volts. Every program or movement activity in progress is canceled and the NC returns to the coordinate reading state (***NCMD***=1), while displaying this message on the video screen.

M.C. off due to emergency.

Every subsequent execution instruction is refused.

The ***EMEA*** signal is also activated following internal NC alarms and alarms associated with transducers and servos.

To exit from this state the cause of the emergency must be removed and the yellow ***BREAK*** control key pushed.

RBRK (Break Request). Is the PLC signal that duplicates the yellow Break key on the NC keyboard. This command, set by the PLC and reset by the NC when acquired, cancels any NC activity in progress. After causing deceleration of the axes it forces the system to the Manual state (***NCMD=***5) movement in manual is not effected. ***RBRK*** cancels ***EMEA*** (emergency status) and ***HOLDA*** (HOLD status).

BRKA (Break Acknowledge). Is a pulse signal with a duration equal to a complete slow logic cycle transmitting a BREAK (reset) order derived from pressing the Break key on the keyboard or as a response to the ***RBRK*** request, so that the PLC can cancel its own activity (for example to stop the spindle).

S1200 In the S1200 system a Break generates the M30 function (program end) and M30 generates a Break, this no longer occurs in the S3045 system.

Summary of Registers and Signals Involved

DHOLD	1	NC ⇦ PLC no	Temporary stop of the program run beginning with the first subsequent block that contains a stop point in the continuous movement (typically an auxiliary function), without interruption of the activity in progress.
FHOLD	1	NC ⇦ PLC no	Temporary stop of feed.
RHOLD	1	NC ⇦ PLC no	External HOLD request. Tempory stop of programmed moves and blocks in execution.
HOLDA	1	NC ⇨ PLC no	Axes in Hold state.
CYST	1	NC ⇦ PLC no	External CYCLE START request.
CYON	1	NC ⇨ PLC no	Cycle in execution.
REME	1	NC ⇦ PLC no	External EMERGENCY request.
EMEA	1	NC ⇨ PLC no	NC in emergency alarm state or external emergency request.
RBRK	1	NC ⇔ PLC no	External BREAK request. Interruption of the program or block in execution. Cancel emergency state.
BRKA	1	NC ⇨ PLC no	Command to BREAK from PLC.

SIGNAL	NC ACTION				
	Program abort	Stop subsequent blocks	Stop programmed movement	Stop manual movement	Forced manual stop
DHOLD		yes (on the next block commanding movment)			
FHOLD			yes	yes	
RHOLD or hold Hold		yes	yes	no!	
RBRK or hold Break	yes	yes	yes		
REME	yes	yes	yes	yes	yes

Notes regarding the display of the status of stop signals

- For the signals ***FHOLD, DHOLD, HOLDA*** there are condition variables which can be used in the screen configuration tables which allow signals to immediately notify the user of the status of the signals described above (see their respective descriptions in the *Configuration System Manual*).
- The default video display tables provided with the NC implement the following:

  FHOLD = 1 or ***DHOLD*** =1 or ***RDMOV*** unlike ***MOVCN*** or ***M6PGM*** =1 which flashes the letters in reverse ***MAPR*** (machine ready); on the MAINTENANCE AREA of the video screen, in addition to the above, the letters appear in reverse separately for each variable.

  HOLDA = 1 causes the word ***HOLD*** to appear in reverse.

  EMEA = 1 causes the softkey ***R.Q. STATUS*** to appear in the main menu and eliminates the other movement softkeys.

In cases of interruption of communication or where the times are too long in the exchange between PC board and MASTER board, the NC goes into emergency status and the following message appears on the screen: "**E32102**: M.T. switched off due to interruption of communication with PC".
The reporting of the alarm implies signalling of the emergency state (EMEA=1) with resultant disabling of the axes and suspension of the program.
If not in a failure condition, the alarm can be removed by means of a BREAK command.

1.4. TOOL ORIGINS AND COMPENSATION

The actions needed in order to activate tool origins and compensation depend on the choice of the type of tool change made in the NC configuration. The details are shown in Chapter 2.3. *Tool Change Management Module.*

1.4.1. MANUAL TOOL CHANGE

No change is necessary in order to retrieve the tool compensations since they are programmed with **T** functions. “Waiting for start” is automatically generated (with the message appearing in lightface type for the operator); the origins are activated separately with the **O** functions.
The **O0** code allows for the passage to absolute origin. **O-1** restores the last origin present before passing to the absolute origin.
The function **T0** nullifies the active correction length.

1.4.2. TYPE S1200 MANUAL TOOL CHANGE

Numbers from T0 to T9 choose from one of the 10 different origins on the plane.

Numbers from T10 to T98 choose one of the 89 adjustment settings of the tool length. Number T99 will recall, for all axes, the transducers’ fixed and absolute origins. This serves for programming movements referring to the fixed zero of the machine and is independent of the zero piece.

Examples:

T1 *recalls origin 1 on the plane*
T23 *recalls the number 23 tool length adjustment setting*

1.4.3. AUTOMATIC TOOL CHANGE

Code **T** programmed is singly and passed to the PLC on the ***TOOL*** register with the strobe ***STROT***.
The tool compensation code is charged in the ***OFST*** register and activated by the synchronous strobe ***INTOF*** (see chapter 2.3. *Tool change Management Module*).

The origins are activated separately by the ***O*** functions.

The code ***O0*** allows for the passage to the absolute origin. ***O-1*** restores the last origin present before passing to absolute origin.

The activation of ***OFST*** = 0 nullifies the active correction length.

In certain cases the PLC can activate the origin by setting the synchronous strobe ***INORG*** after having charged the origin code on ***ORIG.***

When the absolute origin must be activated, in alternation with ***O0***, the synchronous origin bypass signal ***BYORG*** can be set; it stays on this setting until the bypass is reset (on synchronous mode).

The NC informs the PLC of the status of absolute origin present with the signal ***ABSOR***.

Both ***INTOF*** and ***INORG*** are reset by the NC when acquired.

While in absolute origin it is also possible to activate a length compensation by programming 0-1. The system will return to the last active origin before O0, but with the compensation activated.

Summary of Registers and Signals Involved

OFST	16	NC ⇔ PLC	yes	Code of the length compensation to be activated.
INTOF	1	NC ⇔ PLC	yes	Strobe to signal the NC to activate the selected tool length compensation.
ORIG	16	NC ⇦ PLC	yes	Code of the part origine to be activated.
INORG	1	NC ⇔ PLC	yes	Strobe to signal the NC to activate the selected part origine.
BYORG	1	NC ⇦ PLC	yes	Temporary cancellation of origins and tool settings (absolute origine).
ABSOR	1	NC ⇨ PLC	no	Absolute origine active signal.

1.5. COMMANDS REGULATING AXIS FEEDS

The feed speed during execution in automatic mode is regulated from 0 to 200% as a function of the value written on variable ***POFO*** (typically will be equal to an analog input ***ANI()*** whose range varies from 0 to 1).

Example:

POFO = ANI(1) *regulates between 0 and 100%*

POFO = ANI(1)*2 *regulates between 0 and 200%*

1.5.1. ENABLING AND LOCKING AXES

The ***MOVCN*** register is provided by the NC with the configuration of the axes and must be enabled for the movement, by means of the PLC prior to:

- A programmed block or specific geometric function (rototranslation, TCM)
- A movement request in ***JOG*** or the assignment of a handwheel in manual mode
- An axis movement for the home cycle
- The request by the PLC for the axis to remain constantly active

The confirmation of the axes enabled and unlocked and ready to move must be provided in response on the ***RDMOV*** register.

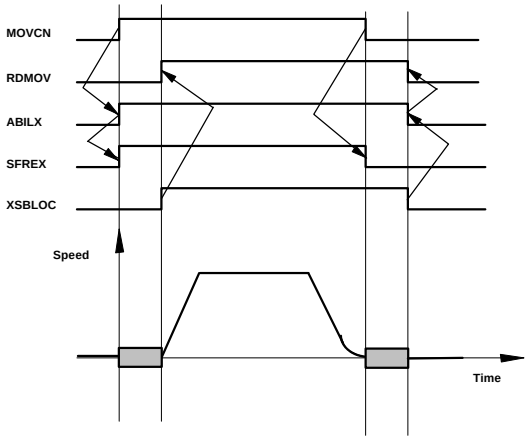
During the period when the registers ***MOVCN*** and ***RDMOV*** are different, that is, in the axis lock/unlock phase, the NC waits for this confirmation before initiating a movement or passing to a subsequent block. It is therefore not necessary to create a wait state using other signals.

The position loop for each axis is closed when an associated ***MOVCN*** or ***RDMOV*** is present.

Avoid ***RDMOV*** activation not corresponding to ***MOVCN*** requests.

Example:

```
INP
XSBLOC              [X axis unlocked
OUT
ABILX               [enable the X axis
SFREX               [X axis release control
...
PROG
SFREX=MOVCN(1)
RDMOV(1)=XSBLOC
ABILX-MOVCN(1)~RDMOV(1)
..
```



Summary of Registers and Signals Involved

MOVCN	8	NC ⇨ PLC	no	Axis enable request (1..8).
RDMOV	8	NC ⇦ PLC	no	Axis ready to move; response to MOVCN (1..8).
POFO	64	NC ⇦ PLC	no	Override value on the programmed feed (from 0 to 2 gives an adjustment between 0 and 200 per cent).

1.5.2. AXES ALWAYS ACTIVE OR WITH LOCKING (M10 - M11)

Through the asynchronous ***SSA*** register, the PLC can request the desired configuration of the axes from the NC as long as they are enabled and interlocked through the position loop.

In manual mode, the NC accepts and performs the requested configuration in asynchronous mode. However, on automatic, avoid alternating ***SSA*** during programs containing movements. It would be best to make it subsequent to auxiliary functions.

Utilizing the ***AXPGM*** register, the function can be made selective only to the axes specified (M11XYZ).

Summary of Registers and Signals Involved

SSA	8	NC ⇦ PLC	no	Axes that must always be active (1..8).

1.5.3. AXIS RELEASE (M45 - M46)

If an axis which is normally under control must be operated by an external system, the PLC can request the configuration of the axes from the NC which need to be released through the synchronous register ***DSERV***. When an axis is released it is disabled, it is ignored if programmed and the reference to it is not operated.

As soon as the axis is again put under control by resetting ***DSERV***, it is once again interlocked on the position in which it is found and enabled, or not, according to the current ***SSA*** register configuration.

The NC accounts for and performs the configuration requested in asynchronous mode.

Utilizing the **AXPGM** register, it can select the function only for the specified axes (M45XYZ).

S1200 In the S1200 system this operation was internally implemented, but rigidly operated by the functions (M45 and M46).

Summary of Registers and Signals Involved

DSERV	8	NC ⇦ PLC	no	Axes to be released (1..8).

1.5.4. TRANSDUCER DISABLING

By setting the bit corresponding to the axis on register ***DISRQ***, it is possible to completely disable the operation of the transducer whenever a transducer must be physically disconnected in order to remove the mechanical unit it is connected to, or for switching between several axes.

This operation leads to the implicit internal release of the axis in question.

The NC accepts and performs the configuration requested in asynchronous mode.

Summary of Registers and Signals Involved

DISRQ	8	NC ⇦ PLC	no	Axis with transducers disabled (1..8).

1.5.5. MANUAL MOVEMENT IN JOG

In NC manual status (***NCMD***=5) it is possible to control the movement of the axes by supplying the direction and velocity. The movement ends when the control is released and the axis is stopped.

S1200 Unlike in the system S1200, JOGs are absolutely necessary, even during the MEMORY SEARCH and the RESTORE CYCLE, in order to enable axes (**NCMD**=8) in the reset to default value mode; however in this status they must not be disabled. (see *Use and Programming Manual*).

The choice of JOG axes is determined by setting the corresponding bit to the axis on register ***MOVMA***. The registers ***JOGP*** and ***JOGM*** initiate the movement and determine the direction.

The axis is enabled and taken under special control, if it does not already exist when the corresponding ***MOVMA*** is furnished.

The velocity is adjusted, individually for each axis, through the related register ***POMO(n)***, with a value between 0 and 1 (0-100% of the rapid velocity).

Summary of Registers and Signals Involved

MOVMA	8	NC ⇦ PLC no	Axes selected for manual movement (1..8).
JOGP	8	NC ⇦ PLC no	Comand jog positive (1..8).
JOGM	8	NC ⇦ PLC no	Comand jog negative (1..8).
POMO()	64	NC ⇦ PLC no	Velocity for manual movments and home cycle for each single axis (1..8) (from 0 to 1 as a percentage of the rapid velocity).

1.5.6. MANUAL MOVEMENT WITH HANDWHEEL

The axes can also be moved with electronic handwheels while in manual state.

The association between the handwheel and the axis to be moved must be made through the PLC program by writing the number of the axis to be moved in register ***HWL(n)*** corresponding to the appropriate handwheel.

Example:

HWL(1)=5 *associates the handwheel 1 to axis 5*

The handwheel resolution can be selected by writing the corresponding number on the ***STEP*** variable, chosen from the 8 values stated in the configuration. Consequently, the resolution value does not need to be written in mm/revolution.

The axes to which the handwheel is assigned in manual mode are automatically enabled.

The manual movement in JOG (selected with ***MOVMA***) has priority over the control given by the handwheel.

Summary of Registers and Signals Involved

HWL()	8	NC ⇦ PLC no	One per handwheel (1..3) to indicate the number of the axis to be controlled.
STEP	8	NC ⇦ PLC no	Selection of the handwheel resolution from the 8 values defined in the configuration parameters.

1.5.7. HOMING THE AXES

In NC manual status (***NCMD***=5) it is possible to home an axis, with or without a zero microswitch, by entering the direction and velocity.

This choice of homing using the marker (encoder or optical lines) is performed by setting the bit corresponding to the axis on the register ***MARK***.

If the homing must be performed using a home microswitch it will be necessary to set the bit for the axes on the register ***MICZE***.

In all cases whether the axis has been homed or not is signaled by the status of the relevant axis bit in register ***MIZEA***.

In the configuration data it is necessary to specify whether or not a home microswitch is present. This information is used by the NC to differentiate special cases such as the use of a resolver connected 1:1 with the motor, or when the transducer used is absolute and does not require any additional PLC management.

For absolute transducers, or those used as such (see preceding case) **MIZEA** is always present unless there are errors on the measurement system.

It is important to remember that the SOFTWARE LIMITS are active *only* after the axes have been homed.

The selection priority of the type of axis movement in JOG (manual and homing) is the following:

MICZE - higher priority
MARK
MOVMA - low priority

Reference cycle using home switches

A phase:

- After having set the bit corresponding to the axis on the register ***MICZE*****,** the axis is enabled and taken under control (if not already).
- With the register ***JOGP*** or ***JOGM*** the movement control is furnished which must be then maintained until the end of the cycle (that is, when register ***MIZEA*** is set).
- The velocity is adjusted as in manual JOG by means of the register ***POMO(n),*** associated with the axis. The value is between 0 and 1 (0-100% referred to the rapid velocity).
- When the home microswitch is reached (indicated by the register ***MIZER)*** the axis is decelerated to a stop.

B phase:

- The move direction is automatically inverted and the velocity is reduced to 1/8 of the actual velocity.
- After having coming off the home microswitch by continuing in the same direction, the transducer is zeroed when the first marker pulse is encountered. The absolute coordinate of the axis is given the value of “machine 0 position” defined in the configuration data (see specific documentation).

C phase:

- The cycle continues automatically, positioning the axis on the position specified in the configuration by the parameter “machine zero,” with the same velocity with which ***MIZER*** is encountered.
- Finally the axis homed signal is given in the ***MIZEA*** register with the bit related to the axis.

If JOG is released during the cycle, the axis is stopped and the following situations will be present:

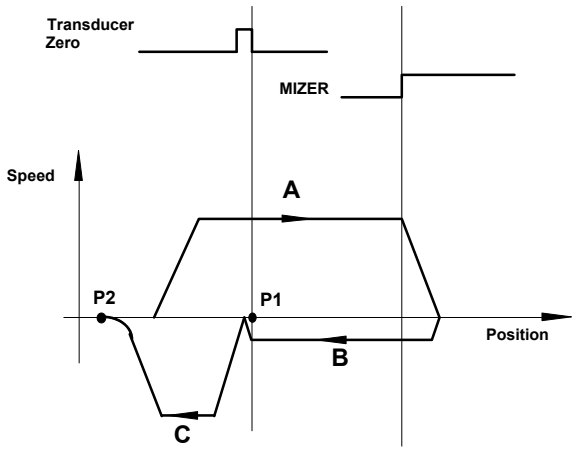
JOG released during “A” phase before being employed by ***MIZER***:	If the transducer had already been zeroed. The value of the previous ***MIZEA*** takes precedence.
JOG released during “A” phase after ***MIZER*** employed but before the electrical zero is encountered.	***MIZEA*** has not been reset.
JOG released in ”C” phase during positioning to machine zero.	***MIZEA*** is signaled in so far as the transducer has already been electrically zeroed even though the axis has not been positioned on machine zero.

If the cycle begins with the home switch already pressed, the sequence initiates from B phase.

In any case, the cycle is always interrupted when the ***MICZE*** register is released.

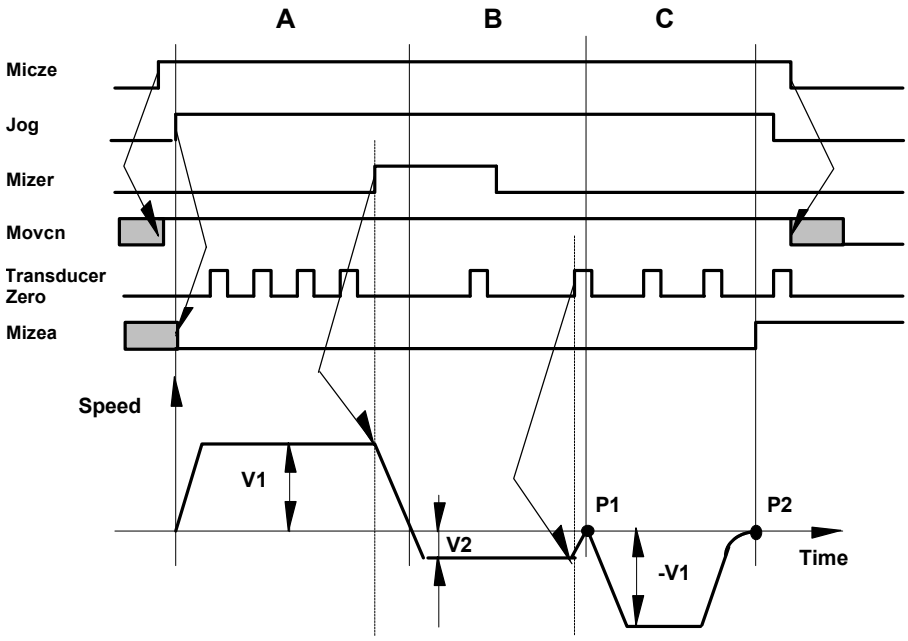
If a repetition of the research cycle is desired after having terminated the preceding one, it is sufficient to repeat the sequence of controls described previously. The ***MIZEA*** signal is again zeroed out and the sequence begins anew.

Reference cycle on microswitch



P1 = point at which value machine zero is entered
P2 = position of end of home cycle

Timing of home cycle on microswitch



P1 = point at which value machine zero is entered
P2 = position of end of home cycle
V1 = home speed
V2 = speed off the switch (1/8 di V1)

Homing using the electrical zero of the transducer (marker)

A phase:

- After having set the bit corresponding to the axis on the register ***MARK*****,** the axis is enabled and taken under control (if not already).
- The movement is maintained until the end of the cycle by the registers ***JOGP*** or ***JOGM*** (when register ***MIZEA*** is set).
- Velocity is adjusted as manual JOG by means of the register ***POMO(n*****)** associated with the axis. The value is between 0 and 1 (0-100% referred to the rapid velocity).
- The transducer is zeroed out on the first electric zero encountered and the axis decelerated to a stop The position of the axis is set by the value of "machine 0 " defined in the configuration data (see specific documentation).

B phase:

- The cycle continues automatically positioning the axis at the point specified in the configuration by the parameter "homing stop position," at the same speed with which the electric zero was encountered.
- Finally the axis homed signal is given in the ***MIZEA*** register with the bit related to that axis

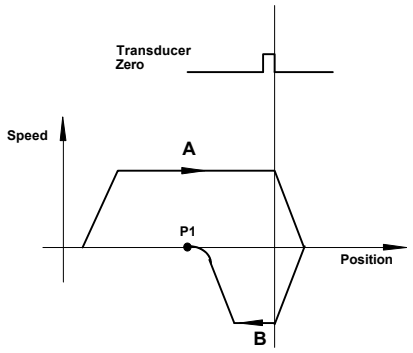
If JOG is released during the cycle, the axis is nevertheless stopped and the following situations would be present:

JOG released before reaching the electrical zero of the transducer:	***MIZEA*** is not reset.
JOG released in "B" phase during positioning to machine zero.	***MIZEA*** is signaled in so far as the transducer has already been electrically zeroed even though the axis has not been positioned on machine zero.

In any case, the cycle is always interrupted when the ***MARK*** register is released.

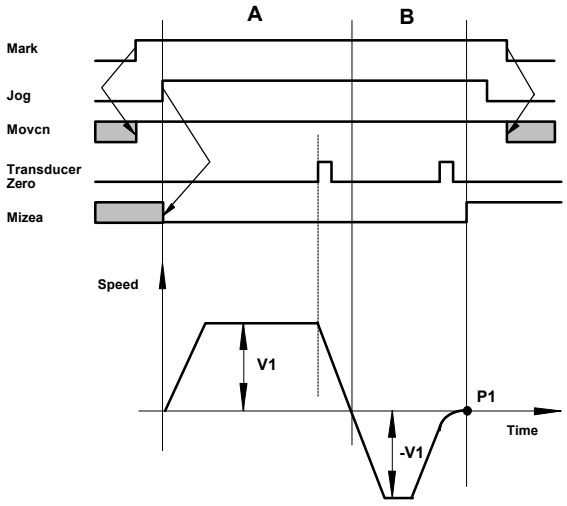
If a repeat of the home cycle is required after having stopped the previous one. Repeat the sequence of controls described previously. The ***MIZEA*** signal is again zeroed out and the sequence begins anew.

Home cycle using marker



P1= position of end of home cycle

Timing of home cycle using marker



P1 = Home cycle position
V1 = Home cycle speed

Homing using optical scales

In order to home the machine using optical scales, the home sequence with microswitch (home switch) must be used, as described above.

The home microswitch (***MIZER()),*** positioned in proximity to the marker position is used to invert the home cycle direction in automatic mode without further action on the part of the PLC.

If during the home cycle the axis moves a greater distance than the maximum specified an error is signaled ***EMEA*** = 1 a message is displayed. This situation may be caused if incorrect configuration parameters are present.

Summary of registers and signals involved

MICZE	8	NC ⇦ PLC	no	Axis selected for homing with home switch (1..8).
MARK	8	NC ⇦ PLC	no	Axis selected for homing without home switch (1..8).
MIZER	8	NC ⇦ PLC	no	Home switch for axis (1..8).
MIZEA	8	NC ⇨ PLC	no	Axes referred to the electrical zero of transducer (1..8).

1.5.8. MOVEMENTS IN MANUAL DURING HOLD STATE

With the execution halted after a HOLD comand (***HOLDA***=1 signal), it is possible without interrupting the program, to enable the movement of the axes in JOG or handwheel, by means of the softkey.

In this state the register ***NCMD*** has a value of 9 if this function is required it is not necessary to inhibit the JOG controls.

To resume the execution of the program it is necessary to use the softkey to select the RETURN TO PROFILE state (***NCMD*** = 8) and reposition the axes on the profile in execution using the JOG FUNCTION (only the controls in the direction towards the piece are automatically enabled).

1.5.9. MOVEMENT IN MANUAL AND REFERENCING DURING PROGRAM EXECUTION

The cycles for manual movement and referencing can be performed during the execution of a program, on condition that the axis bit in the synchronous register ***FOMAN*** is set (forced) for manual mode.

This status causes the release of the axis.

The NC performs the configuration requested in synchronous mode.

Summary of Registers and Signals Involved

FOMAN	8	NC ⇦ PLC	yes	Axes on which to force manual control (1..8).

1.5.10. INFORMATION REGARDING THE AXES

Through a set of previously defined registers it is possible, at any given moment, to read any important information related to any single NC axis for the purpose of debugging, calibration or, in isolated cases, in order to implement algorithms of a particular type.

In the table that follows, the registers have been divided into three areas in with detailed descriptions of the signals and registers.

Summary of Registers and Signals Involved

For axis control

ERR()	64	NC ⇨ PLC	no	Axis following error (1..8).
VATT	64	NC ⇨ PLC	no	Actual velocity along the tool path.
TACH()	64	NC ⇨ PLC	no	Axis velocity (1..8) .
VFF()	64	NC ⇨ PLC	no	Instantaneous velocity axes (1..8).
AFF()	64	NC ⇨ PLC	no	Instantaneous acceleration axes (1..8).
DAA()	64	NC ⇨ PLC	no	Reference voltage for controlled axes (1..8). The DAA can only be read If the axis is active and under NC control. The content varies from -1 to 1 in relation to the input voltage of -10 and +10 V.
POA()	64	NC ⇨ PLC	no	Absolute position of axes (1..8).
POO()	64	NC ⇨ PLC	no	Axis position refered to the current origin and active tool compensation (1..8).
POATE()	64	NC ⇨ PLC	no	Instantaneous calculated axis position along the trajectory of interpolation (1..8) relative to the absolute origin.
POOTE()	64	NC ⇨ PLC	no	Instantaneous calculated axis position along the trajectory of interpolation (1..8) relative to the active origin.
POORT()	64	NC ⇨ PLC	no	Instantaneous calculated position of any rototranslation of system coordinates along the trajectory of interpolation (1..8) relative to the active origin.
PFNC()	64	NC ⇨ PLC	no	Final programmed axis position (1..8).

Axis status

INTOL	8	NC ⇨ PLC	no	Axis (1..8) within “in position zone” defined in the parameters.
JOGIN	8	NC ⇨ PLC	no	Axis (1..8) moving following a JOG command (manual or referencing).
RAPI	1	NC ⇨ PLC	no	Blocks being executed in rapid.

Control of transducers and electronic handwheels

MKSAX	8	NC ⇨ PLC	no	Marker pulse signal (electrical zero) for encoders or optical scales for axes (1..8). Set by the NC when received from the transducer and reset by the subsequent system sampling; for this reason the pulse is only seen by using the graphic analyser .
AIRGP()	64	NC ⇨ PLC	no	Signal level from analog transducers (INDUCTOSYN or RESOLVER); in the case of an ENCODER it is the number of lost pulses determined by the "recover step" function for the axes (1..8).
SPMANO()	64	NC ⇨ PLC	no	Distance per rev of the handwheel (1..3) according to the selected resolution. The distance accumulated is reset by changes of NC status and axis status (SSA, DSERV, ...)

Information regarding the axes: entity of origin offset (*G851*)

The values in millimetres, for each machine axis respectively, of the offset of the origin obtained with the handwheels when function ***G851*** is active are loaded on the 8-element vector **OFHWL()**.
The entity of the offset can be displayed on the NC video panels by using the display variables available in the PLC.

Name	*Size*	*Direction*	*Description*
OFHWL()	64	NC=>PLC	Offsets (1..8) of the workpiece origin through ***G851***

Information regarding controlled axes: new variables

Variables for debugging and axis calibration:

Name	*Size*	*Direction*	*Description*
AXRIF()	64	NC ⇒ PLC	Speed command sent to the axes (1..8) [mm/min].
OFSVA()	64	PLC ⇒ NC	Additional speed offset for the axes (1..8) [mm/min]. (Also impacts AXRIF() - use only for special applications)
AFF()	64	NC ⇒ PLC	Acceleration command imparted to the axes (1..8) [mm/sec^2]

1.5.11. DYNAMIC COMPENSATION OF AXIS POSITION

The PLC has the ability to write a value directly on the ***SHIFT*** registers (in millimeters) to compensate dynamically for variations in axis position caused by by thermal or mechanical deformation.

The compensation will act in two different modes according to whether or not the axis is interlocked:

interlocked axis: the position displayed does not vary, but physically the axis is moved by the the amount indicated by ***SHIFT***.

non-interlocked axis: the axis can does not move itself, but the position value varies by the amount indicated by SHIFT**.**

Summary of Registers and Signals Involved

SHIFT()	64	NC ⇦ PLC	no	Dynamic compensation of axis position (1..8).

1.5.12. OFFSET FOR CONTROLLED AXES

For special applications it is possible to add an offset to the analog reference calculated for the controlled axes. This function must be used with extreme caution since values that are not appropriate will cause errors in the motion of the NC axes.

Summary of Registers and Signals Involved

OFSDA()	64	NC ⇦ PLC	no	Offset to be applied to the reference voltage on controlled axes (1..8) in the range ±1 for a reference voltage of ±10 Volt.

ADDITIONAL ORIGIN OFFSET FOR CONTROLLED AXES

For special applications, a supplementary position offset may be activated for the workpiece origins through the PLC. The origin offset remains active even after the Numerical Control has been switched off, thus guaranteeing position in cases of absolute transducers.
The value of the offset, expressed in millimetres or degrees, must be loaded into the 8-element vector **PLORG()** (one for each axis respectively). The offsets are activated with an end-of-block M function which sets the bit **STORG_(1)** synchronously with the BURDY signal. The other bits of the byte **STORG_** are reserved for other axis groups.
Similarly, all the additional offsets are de-activated by setting **STORG_** to 0 synchronously.
It is important to remember that activation and de-activation of the offsets take place only after a transition of the bit **STORG_(1)** from zero to one or from one to zero respectively. For example, if the system starts with the bit at zero, only the rise to one is active and vice versa. Therefore in order to maintain consistency with the internal storage status of control of the axes, it is recommended that you create a support bit in static RAM (SRAM) to store the status **STORG_** with the NC off and reinitialize it on switching on.

Typically this feature is used on machines with rotational head and with a second, opposing spindle; the additional offsets represent the position differences between the first spindle «nose» and the «second» spindle.
In this case, the activation of **STORG_** is produced on an end-of-block auxiliary M function inside a COM program used for the exchange of spindles.
In an absolute origin, the origin offsets are disabled.

Name	*Size*	*Direction*	*Description*
STORG_	8	PLC ⇒ NC	Register activating the additional origin offsets. STORG_(1) = 1 enables the offsets (for all the axes) STORG_(1) = 0 disables the offsets
PLORG()	8	PLC ⇒ NC	Registers containing the additional origin offsets

1.6. MANAGEMENT OF CONTACT MEASUREMENT PROBE

If the system detects an excessive probe deflection signal (error 210), it sets a state of emergency (collision of contact probe).

The PLC can disable this error sensing by setting bit 1 of the variable ***CWDTF***.

Summary of Registers and Signals Involved

CWDTF	8	NC ⇦ PLC	no	Control byte of contact Probe (on/off): Bit 1: disables error 210 (collision)

Status of the measurement probe (ON/OFF) can be read through register **SWDTF** (this register is to be used mainly for diagnostic purposes).

Name	*Size*	*Direction*	*Description*
SWDTF	8	PLC=>NC **SWDTF(2)**	Status of probe ON/OFF = 0 probe at rest = 1 probe deflected

1.7. AXIS SOFTWARE LIMITS

The status of the axis software limit is signaled on the registers ***FICOP*** and ***FICOM*** (positive and negative limits).

The PLC has the ability to disable the software limits by raising the related bit to the axes on the registers ***DFCOP*** (positive limit disabled**)** and ***DFCOM*** (negative limit disabled).

Summary of Registers and Signals Involved

FICOP	8	NC ⇨ PLC	no	Axis (1..8) on positive software limit.
FICOM	8	NC ⇨ PLC	no	Axis (1..8) on negative software limit.
DFCOP	8	NC ⇦ PLC	no	Axis (1..8) disable positive software limit.
DFCOM	8	NC ⇦ PLC	no	Axis (1..8) disable negative software limit.

CONTROLLED AXIS SOFTWARE LIMITS: DE-ACTIVATING ERROR E93

By setting the variable **CWFCS** it is possible to disable the detection prior to the software limit movement and, as a result, the reporting of error «**E93**: AXES ON LIMIT»; limiting of the stroke of the axes due to the software limits remains, however, unaltered.
This features must be used when the PLC, for installation requirements, also acts, and with the axes moving, on the variables relating to the software limits, for example by disabling the limits with **DFCOP**, **DFCOM** or by changing the pair of active limits – variable **FCA**).
In the NC program execution or single block states, setting of **CWFCS** must be made synchronously with the signal BURDY.

Name	*Size*	*Direction*	*Description*		
CWFCS	8	PLC ⇒ NC	Check of software limit errors		
			CWFCS(1)	= 1	check **E93** disabled
				= 0	check **E93** enabled (default).

1.7.1 ADDITIONAL SOFWARE LIMITS

In configuration parameters it is possible for each axis to introduce a second pair of software limits when changes dimensions in the operative field occur. These parameters must be activated through PLC program (for example in a tool crib within a change of work).

Example :

Consider a configuration with X,Y,Z where secondary limits must be activated on Z axis:

FCA(3)=2 *[Activate secondary limit pair Z axis*

To go back TO primary limits it is identical writing:

FCA(3)=1 *[Activate primary limit pair Z axis*

or:

FCA(3)=0 *[Deactivate management additional limits Z axis*

If array ***FCA*** is not used, primary limits on all controlled axes are active by default.

Summary of signals and registers involved

FCA( )	8	NC ⇦ PLC	no	Secondary limits array activation for NC axes (1..8)

1.8. SPECIAL TYPE AXIS MANAGEMENT

1.8.1. PARALLEL (GANTRY) AXES

Gantry axes are normally managed by the NC system software according to the configuration parameters.

Configuration parameters concerning acceleration and speed must be identical. MASTER axis is associated to a name chosen by the user the secondary axis is called SLAVE.

The interface PLC with NC is only for MASTER axis except for the recognition signal of the zero micro. Commands such as **JOG** (manual movement), **POMO** (speed regulation), **MICZE**, **MARK** (homing), **MOVCN**, **RDMOV**, **SSA** (control signals and servo enabling) are required on MASTER axis only.

MIZER (zero micro signals) must be written for both axes even if the two signals come from the same input. During the normal running the two axes will be syncronized with an offset written in a configuration parameter ***NOMINAL OFFSET GANTRY.***

Enabling command of this offset is the bit in the ***OFSGY*** variable corresponding to the number of the SLAVE axis. If ***OFSGY()*** is zero the axes are interlocked and moved keeping the offset postion initially detected during the NC start up. When the axes are not absolute this syncronization comes only after the recognition of both zeros and before this event the axes are interlocked with the initial offset. Installing the interlocking operation, when the offset value is unknown ***OFSGY*** is kept disabled.

Homing with micro for GANTRY axes

- Set **MICZE** register for the MASTER axis then give **JOG** command in the direction required, the speed value on **POMO**, as for a normal axis.
- SLAVE axis follows MASTER axis keeping the offset read during the start up untill both of the axes reach the zero micro (signalled by **MIZER**).
- Axes pair reverse direction at a reduced speed of 1/8 in order to release zero micro.
- The movement continues until the two zero marker are read.
- NC transmits to PLC the two bits on ***MIZEA*** relative to two axes and if enabled by ***OFSGY*** it applies the gantry offset written in configuration parameter ***NOMINAL OFFSET GANTRY***.

Summary of Registers and Signals Involved

OFSGY	8	NC ⇦ PLC no	Enable nominal offset gantry axis (1..8) Must be set the bit corresponding to the SLAVE axis number

1.8.2. PROGRAMMABLE NON - CONTROLLED AXES

If a move is programmed for an axis not defined as a controlled axis,the programmed position is passed to the PLC via the array ***AUXPF()*** accompanied by the synchronous strobe ***STRPF***.

For these axes the PLC will execute the move utilizing if necessary, the INDEPENDENT AXIS MODULE.

The programmed positions are passed on the array **AUXPF*()*** as follows:

AUXPF(1) = position of axis A with strobe ***STRPF(1)***
AUXPF(2) = position of axis B with strobe ***STRPF(2)***
AUXPF(3) = position of axis C with strobe ***STRPF(3)***
AUXPF(4) = position of axis U with strobe ***STRPF(4)***
AUXPF(5) = position of axis V with strobe ***STRPF(5)***
AUXPF(6) = position of axis W with strobe ***STRPF(6)***

Summary of Registers and Signals Involved

AUXPF()	64	NC ⇨ PLC ye	Programmed positions for axes moved by the PLC (1..6).
STRPF	8	NC ⇨ PLC ye	Strobe when new information is present on ***AUXPF***() (1..6).

1.8.3. MASTER SLAVE AXES (NC «MS» OPTION)

Through function ***G15*** (only on arranged systems) it is possible to «lock» two machine axes (a main one called Master and a secondary one called Slave) in such a way that all the movement commands imparted to the Master axis are also executed by the Slave.

The syntax is: ***G15*** slave_axis master_axis I...
(I represents a scaling factor between the two movements).

Function ***G14*** cancels ***G15***.
For more detailed information on the subject, see *Technical Bulletin 1 of 1996*.

1.8.4.READING INPUTS AND WRITING ANALOG OUTPUTS: REMOTE I/O MODULES

For the interfacing of inputs, analog outputs, temperature probes through Remote I/O modules, no configuration parameters are necessary in the NC.
The reading of analog inputs provides the PLC a numeric value in 64 bit format, variable between 0 and 1 as a percentage of the bottom of scale value.

Analog inputs

The syntax is as follows:
ANImaster board number (slave number input number)

where:

master board number	indicates which BOARD SLOT the board with RIO master interface will have, like the case of local I/O where it relates to the I/OMIX board. If the master board with integrated RIO is used, the board number will be 17.
slave number	declares the address set with the microswitches on the remote module.
Input number	declares the input used on the module.

Example:

ANI17(6002) signifies analog input no. 2 of the SLAVE remote module with address 60 connected to the RIO MASTER interface in position 17.

ANI(3) signifies analog input channel 3 of the first I/OMIX board

Analog outputs

The analog outputs written by the PLC with a numeric value in 64 bit format varying between -1 and 1 as a percentage of the bottom of scale value produce an output voltage varying between -10V and +10V.
No configuration parameters are necessary in the NC.

The access is obtained in the PLC with a variable VELO... with the following structure:
VELOmaster board number (slave number output number)

where:

master board number indicates which BOARD SLOT the board with RIO master interface will have, like the case of local I/O where it relates to the I/OMIX board.

slave number declares the address set with the microswitches on the remote module.

output number declares the output used on the module.

Example:

VELO17(6002) signifies analog output no. 2 of the SLAVE remote module with address 60 connected to the RIO MASTER interface in position 17.

VELO(3) signifies analog output no. 3 of the first I/OMIX board.

Inputs for temperature probes

Reading of the analog inputs for temperature probes provides the PLC a value in degrees of the temperature detected by the heat probes in 64 bit format.

No configuration parameters are necessary in the NC. In the PLC program, access is obtained with a variable TEMP... of the following structure:

TEMPmaster board number (slave number input number)

where:

master board number indicates which BOARD SLOT the board with RIO master interface will have, like the case of local I/O where it relates to the I/OMIX board.

slave number declares the address set with the microswitches on the remote module.

input number declares the input used on the module.

Example:

TEMP17(6002) signifies input probe no. 2 of the SLAVE remote module with address 60 connected to the RIO MASTER interface in position 17.

1.9. READING AND WRITING ANALOG INPUTS AND OUTPUTS

The PLC has the ability to directly access the physical analog input and output channels.

Every element in the following registers has as an index, the physical channel number and a board number at the end of its name.

Example:

ANI2(3) signifies the analog input channel 3 of the second card I/OMIX

ANI(2) signifies the analog input channel 2 of the first card I/OMIX

Summary of Registers and Signals Involved

ANIx()	64	NC ⇨ PLC no	Analog input readings from the I/OMIX card specified and its expansions. The value read varies from 0 and 1 as a percentage of the full-range value..
VELOx()	64	NC ⇦ PLC no	Analog output from the I/OMIX card specified and its expansions. These outputs can always be read, but written only if they are not utilized by the NC for the controlled axes or by the internal modules for management of the spindles or independent axes. The content can vary from -1 to 1 as a percentage of the full-range value (+/- 10 V).
TEMPx()	64	NC ⇨ PLC no	Degrees of temperature read by the thermal probes (if the interface is present) associated with the specified card.

1.10. EXCHANGE OF DATA BETWEEN PLC AND PART PROGRAM

The PART PROGRAM has the ability to exchange data with the PLC in the BIT, BYTE, WORD, and LONG formats through the instructions:

OUT(format) = parameter to send the parameter to the PLC
Pxx = INP (format) to receive a value from the PLC

where:

format can be 1, 8, 16, 32, respectively identifying BIT, BYTE, WORD, LONG.

parameter can be the result of an expression, a ***Pxx*** parameter or a number in explicit mode.

The summary below shows the format and direction of the information in the variables; where data passes from part program to PLC a strobe signals that a new value is present.

In turn, the PLC can directly read or write to the **Pxx** parameters (from P1 to P99) of the NC with the array variables **PNC*()*** (from ***PNC(1)*** to ***PNC(99)***)**.**

For programs run with ***COM*** instructions a set of parameters exists in the PLC from ***P(1)*** to ***P(99)*** these correspond to the ***Pxx*** used in the program running.

These have the same name, but they have nothing to do with the ***Pxx*** parameters of the part program executed directly by the operator.

Summary of Registers and Signals Involved

VPLFL	32	NC	⇨ PLC	yes	FLOATING variable from part program to PLC.
STVFL	1	NC	⇨ PLC	yes	FLOATING variable strobe from part program to PLC.
VPLWO	16	NC	⇨ PLC	yes	WORD variable from part program to PLC.
STVWO	1	NC	⇨ PLC	yes	WORD variable strobe from part program to PLC.
VPLBY	8	NC	⇨ PLC	yes	BYTE variable from part program to PLC.
STVBY	1	NC	⇨ PLC	yes	BYTE variable strobe from part program to PLC.
VPLBI	1	NC	⇨ PLC	yes	BIT variable from part program to PLC.
STVBI	1	NC	⇨ PLC	yes	BIT variable strobe from part program to PLC.
VLPFL	32	NC	⇦ PLC	yes	FLOATING variable sent to the part program from the PLC.
VLPWO	16	NC	⇦ PLC	yes	WORD variable sent to the part program from the PLC.
VLPBY	8	NC	⇦ PLC	yes	BYTE variable sent to the part program from the PLC.
VLPBI	1	NC	⇦ PLC	yes	BIT variable sent to the part program from the PLC.
PNC()	32	NC	⇔ PLC	no	99 parameters in shared floating point format read and written to by both PLC and part program at the user level (1..99).
P()	32	NC	⇔ PLC	no	99 parameters in shared floating point format written to by the PLC or the subprogram COM instructions (1..99).

1.11. NC VIDEO DISPLAY WINDOWS

A set of previously defined variables allows the PLC to display data in the NC screen area (see the *System Configuration Manual*).

Summary of Registers and Signals Involved

WINDOW()	64	NC	⇦ PLC	no	Registers for NC video display areas (1..16) in the floating long or double point formats. The display of these areas is enabled by default values in the video tables.
ASCW()	8	NC	⇦ PLC	no	Registers for NC video character display in the preset areas (1..16). The ASCII character code must be used.
WNDINT()	16	NC	⇦ PLC	no	Registers for NC video character display in the preset areas(1..16) in word format.
WNDSTR()	str	NC	⇦ PLC	no	String registers containing a max of 64 alphanumeric characters for the NC video display in the preset area (1..16).
GIRMI	64	NC	⇦ PLC	no	Register for the display of the S function value in the preset area of the NC video.

It should be remembered that, as described with regard to the softkey, the PLC can change the current softkey menu by using the variable **SFKMEN**.

Remember, the PLC may change the softkey menu using ***SFKMEN*** variable.
Furthermore the PLC has the code of the active language on NC on the ***SFKLNG*** variable:

1= **Italian**
2= **French**
3= **German**
4= **English**
5= **Spanish**
6= **Portuguese**

To create a new condition in the video configuration tables the array ***CNDVIS( )*** of 64 elements in word format (see *Configuration System Manual*) is available.

Summary of Registers and Signals Involved

SFKMEN	8	NC ⇔ PLC	no	Current PLC softkey menu.
SFKLNG	16	NC ⇨ PLC	no	Active language code on NC
CNDVIS( )	16	NC ⇦ PLC	no	Word array to use during changing condition in the tables (1…64)

NC VIDEO DISPLAY WINDOWS: ACTIVE VIDEO PANEL

The variable **VISMC** (read only) contains the number of the video panel (**VIS_MC**) currently active.
The panels from **VIS_MC_A** to **VIS_MC_F** output codes from 10 to 15 respectively.

Name	*Size*	*Direction*	*Description*
VISMC	16	NC ⇒ PLC	Number of active video panel

1.12. SYSTEM DATE AND TIME

The system date and time are available (in numerals and read-only) on an vector of 6 elements in the WORD format (seconds have a tolerance of +/-1).

Summary of Registers and Signals Involved

DATE(1)	16	NC ⇨ PLC	no	Year (last two digits)
DATE(2)	16	NC ⇨ PLC	no	Month
DATE(3)	16	NC ⇨ PLC	no	Day
DATE(4)	16	NC ⇨ PLC	no	Hour (0-24)
DATE(5)	16	NC ⇨ PLC	no	Minutes
DATE(6)	16	NC ⇨ PLC	no	Seconds

1.13. SIGNALS FOR COPYING AND DIGITIZING SURFACES

To enable controls related to the functions of copying and digitizing used on the remote console the PLC can act on the variables described below:

Summary of Registers and Signals Involved

COPIA	8	NC ⇔ PLC	no	First byte for remote copying commands

The meaning of the single bits are as follows:

COPIA(1)	1	NC ⇦ PLC	no	= 0	selects continuous digitization mode data points are stored as a function of the parameters of the manual copy program.
				= 1	selects the digitization mode data points are stored only following an pulse (transition from 0 to 1) on the bit COPIA(2) in manual copy.
COPIA(2)	1	NC ⇦ PLC	no	Digitizing signal see ***COPIA(1)***.	

COPIA(3)	1	NC ⇔ PLC	no	Active copying cycle signal. When reset by PLC it signifies the end of the cycle. It is important to terminate a digitizing cycle by zeroing out this bit (or with the appropriate softkey if already implemented in the NC) otherwise the last points digitized will not be stored.
COPIA(4)	1	NC ⇦ PLC	no	Signal to STEP (increment) +.
COPIA(5)	1	NC ⇦ PLC	no	Signal to STEP (increment) -.
COPIA(6)	1	NC ⇦ PLC	no	Signal to STEP (increment) and reverse copy direction.
COPIA(7)	1	NC ⇨ PLC	no	Active copy.
COPIA(8)	1			Not assigned

COPIA2	8	NC ⇔ PLC	no	Second byte for remote control of copy function.

The meaning of the single bits are as follows:

COPIA2(1)	1	NC ⇦ PLC	no	Passage in manual status.
COPIA2(2)	1	NC ⇦ PLC	no	0 = digitizing disabled. 1 = digitizing enabled.
COPIA2(3)	1	NC ⇦ PLC	no	Probe offset acquired.
COPIA2(4)	1	NC ⇦ PLC	no	1 = copying axis 1 locked. 0 = unlocked.
COPIA2(5)	1	NC ⇦ PLC	no	1 = copying axis 2 locked. 0 = unlocked
COPIA2(6)	1	NC ⇦ PLC	no	1 = copying axis 3 locked. 0 = unlocked
COPIA2(7)	1	NC ⇦ PLC	no	Reversal of copy direction.
COPIA2(8)	1	NC ⇦ PLC	no	0 = auto acquire surface disabled. 1 = auto acquire surface enabled.

COPIA3	8	NC ⇔ PLC	no	Third byte for remote copying commands.

The meaning of the single bits are as follows:

COPIA3(1)	1	NC ⇦ PLC	no	Restart copying in the negative direction after loss of contact with the model axis 3.
COPIA3(2)	1	NC ⇦ PLC	no	Restart copying in the negative direction after loss of contact with the model axis 2.
COPIA3(3)	1	NC ⇦ PLC	no	Restart copying in the negative direction after loss of contact with the model axis 1.
COPIA3(4)	1	NC ⇦ PLC	no	Restart copying in the positive direction after loss of contact with the model axis 3.
COPIA3(5)	1	NC ⇦ PLC	no	Restart copying in the positive direction after loss of contact with the model axis 2.
COPIA3(6)	1	NC ⇦ PLC	no	Restart copying in the positive direction after loss of contact with the model axis 1.
COPIA3(7)	1	NC ⇦ PLC	no	Reserved.
COPIA3(8)	1	NC ⇦ PLC	no	Reserved.

COPIA4	8	NC ⇔ PLC	no	Fourth byte for remote control of copying functions.

The meaning of the single bits are as follows:

COPIA4(1)	1	NC ⇦ PLC	no	Tempory stop after renewed contact with model.
COPIA4(2)				Reserved
COPIA4(3)				Reserved
COPIA4(4)				Reserved
COPIA4(5)				Reserved

COPIA4(6)			Reserved
COPIA4(7)			Reserved
COPIA4(8)			Reserved
POCOP	64	NC ⇦ PLC no	Manual copying gain control. The value can vary from 0 to 1 and multiplies the gain of the control in copying from 1 to 5, varying the velocity of the axes with the deflection of the probe.

SIGNALS FOR COPYING AND DIGITIZING: ACTIVE MANUAL COPYING

The NC sets bit 8 of byte COPIA to signal execution in progress of a scanning cycle in manual mode.

Name	*Size*	*Direction*	*Description*
COPIA	8	NC ⇒ PLC	First byte for remote management of copy commands COPIA(8) manual copy scanning active

1.13.1 STATUS REGISTER OF COPYING AND DIGITAL PROBE

If a digital probe will be for copying and digitizing the register ***PBSTS(1)*** is available where the single bits assume the following meaning:

PBSTS(1)	not used
PBSTS(2)	not used
PBSTS(3)	not used
PBSTS(4)	not used
PBSTS(5)	=1 if probe electric signals are correct =0 if not
PBSTS(6)	=0 if the probe is connected and is not in overdeflection =1 if not
PBSTS(7)	not used
PBSTS(8)	not used

If there are any faults when the probe is installed, the system automatically generates error signals on the ***PBSTS*** register passing to the emergency status (***EMEA=1***).

The probe is considered present by the NC only when the configurations of ***PBSTS(5)=1*** and ***PBSTS(6)=0*** have been detected while the probe is considered absent with ***PBSTS(5)=0*** and ***(PBSTS(6)=1***.

Summary of Registers and Signals Involved

PBSTS	8	NC ⇨ PLC no	Status register digital probe.

1.14. VARIABLES TO VERIFY SYSTEM EXECUTION TIMES

The variables summarized below are available for evaluating the the time taken by the system to execute various operations:

Summary of Registers and Signals Involved

SMPTI	64	NC ⇨ PLC	no	Sample time (controlled axes) [msec]
OCCV	16	NC ⇨ PLC	no	Fast logic scan time (microseconds).
OCCI	16	NC ⇨ PLC	no	Time used in managing the controlled axes (microseconds).
OCCT	16	NC ⇨ PLC	no	Time used by the graphic analyser (microseconds).
OCCP2P	16	NC ⇨ PLC	no	Time used in managing the independant axes (microseconds).
CCL	16	NC ⇨ PLC	no	Slow logic interrupt cycle counter.
CCUL	16	NC ⇨ PLC	no	Super slow logic interrupt cycle counter.

1.15. ERROR SIGNALS ACCESSED BY THE LOGIC

System errors (besides being displayed on the screen) are communicated to the PLC with a numeric code on the ***ERSYS*** variable.

The complete list of errors is reported in the manual *Use and Programming*.

Summary of Registers and Signals Involved

ERSYS	16	NC ⇨ PLC	no	System error code read on the controlled axes, spindles, independent axes, PLC runtime errors, errors in the automatic tool change module,
ERAXS	16	NC ⇨ PLC	no	System error code read on the controlled axes (slave error, ouside tolerance, transducer errors, etc.).
ERIOX	16	NC ⇨ PLC	no	Error code read on the I/OMIX cards (encoder feedback failure, digital output error, etc.)
ERINT	16	NC ⇨ PLC	no	Error code occurring during the interpolation calculations.
ERPLC	16	NC ⇨ PLC	no	Runtime error code read during the execution of the PLC program (division by 0, overflow, underflow, etc.).
ERSPN	16	NC ⇨ PLC	no	Error code read on the spindles (transducers, etc.)
ERP2P	16	NC ⇨ PLC	no	Error code read on the independent axes (transducers, etc.)
ERCU	16	NC ⇨ PLC	no	Error code read during tool change or incorrect tool tables, etc.
ER2LN	16	NC ⇨ PLC	no	Error code caused by exceeding system sampling time.
ERCPY	16	NC ⇨ PLC	no	Error code read during a copying cycle or touch probe sensor.
FPERMK	8	NC ⇦⇨ PLC	no	Disabling mask that senses errors on floating point calculations (division by zero, overflow).

CHECKING OF THE INDICES FOR ACCESS TO VARIABLES AND TABLES.

With the object of diagnosing whether the value of the indices used for accessing the individual bits of simple variables or the elements of a vector come inside the limit dimensions of the variables, the following instructions can be added in the PLC program:

_ENIDX = -1 to activate diagnostic
_ENIDX = 0 to de-activate it (default)

The check can be activated and de-activated many times in the PLC program (only in one program section at a time).
Execution of the PLC program is slowed with these checks active.
Where an error situation is detected, a message is reported in clear and the PLC is disabled.

1.16. READING AND MODIFING AXIS CONFIGURATION PARAMETERS

In order to use sophisticated auto-calibration techniques, the PLC has the ability to read and temporarily or permanently modify some controlled axis parameters. These parameters are normally defined in the configuration data.

Use of this service requires great care, since incorrect data can cause malfunctioning of the axes.

To access these parameters, it is first of all necessary to select the desired NC axis, and then furnish the ***AXSTP*** register with the axis number in the configuration data, then the parameter will be selected with the ***HOWSTP*** register as well as the type (read or write).

To perform the operation, it is necessary to activate the ***ACTSTP*** strobe. This is then reset by the response from the NC.
The value of parameter selected must be written or read on the ***VALSTP*** register.
The changes to the parameters are permanently stored in the configuration tables only by utilizing the UPDATE FILES operation (***HOWSTP*** = 0).

Summary of Registers and Signals Involved

AXSTP 8 NC ⇦ PLC no Number of the axis whose parameters are to be modified.

VALSTP 64 NC ⇔ PLC no Current value in the system configuration parameters.

16 NC ⇦ PLC no Configuration parameter code to access through the PLC (the parameters operate on a non static copy in memory); the new values are entered only when the axis final velocity = 0:

Code written	Parameter	Code read
-1	Rapid velocity	1
-2	Machining acceleration	2
-3	Rapid acceleration	3
-4	transducer axis backlash	4
-5	K_v gain	5
-6	Dynamic compensation	6
-7	Crossover recovery rate	7
-8	Crossover recovery time	8
-9	Maximum Servo Error	9
-10	Frict. comp rate	10
-11	Acceleration error offset	11
-12	Negat. travel limit 1	12
-13	Posit travel limit 1	13
-14	Transducer pitch	14
-15	Integral time constant	15
-16	Integral gain	16

ACTSTP 1 NC ⇔ PLC no Start operation request signal on **HOWSTP**. Reset by NC when operation is finished.

INCH 1 NC ⇔ PLC no Kind of measure
0 = millimeters
1 = inches
The NC sets this variable according to the related parameter stored in the system configuration area.
PLC can overwrite this variable to change the kind of measure but the new value will not be saved permanently in the system configuration parameter area.

1.17. MANAGEMENT OF NUMEROUS SIMULTANEOUSLY INTERPOLATING AXIS GROUPS (GDA).

Subject to declaration in the CNC Setup parameters, it is possible to configure up to 8 interpolating axis groups, each capable of executing a program or program parts completely independently.
As a result the PLC variables for the exchange with the machining program have also been changed.
The rules used to generate the new variable names are as follows:

- for bit format variables a byte has been created in which each bit corresponds to a group of axes;

Example: bit BURDY is extended in byte BURDY_
addressing BURDY or BURDY_ (1) is the same thing.
For the GDA higher than the first, use BURDY_ (..).

- for variables with other formats arrays of 8 elements have been created (one for each axis group).
- the name of the new variables is obtained by adding an "_" (underscore) after the original name.

At user interface level the key above the < Return> key can be used to pass (if configured) from the display of one group of axes to the next.

For the synchronization and running of programs on different groups of axes new part-program instructions have been introduced.
For further details, see the relative *Technical Bulletin no. 4 of 1997*.

INFORMATION REGARDING THE AXIS GROUP DISPLAYED.

The variable **GDAVIS** communicates to which group of axes the current console display refers.
This information is of use, for instance, as it is the role of the PLC to keep updated the display of the last M programmed for each axis group, depending on which GDA is displayed on the console by the user.

Name	*Size*	*Direction*	*Description*
GDAVIS	8	NC ⇒ PLC	Number of the axis group that the display refers to.

1.18.MANAGEMENT OF DIGITAL DRIVES FOR AXIS AND SPINDLE

With introduction of the interface of digital drives for axes and spindles, many of the exchange signals traditionally managed as input/output of the PLC and of the drives have now become part of the interface register signals.
The description of the PLC variables and their operation has not been provided in this manual on account of the sheer size of the topic; refer instead to the *"DDI – DCM Regulation Board Installation Manual".*

2. DEDICATED INTERNAL MODULES

It is possible to use the **INTERNAL MODULES**, to simplify the management of frequently used complex functions. By setting some variables you obtain the desired effect without having to implement complicated algorithms. In this way a more readable program with reduced development time is obtained .

2.1. SPINDLE MANAGEMENT MODULE

Up to 4 spindles are allowed with or without transducers. They are controlled directly by a reduced set of pre-defined registers belonging to the **INTERNAL SPINDLE CONTROL MODULE.**

Functions are:

- acceleration/deceleration ramps
- speed regulation based on range and value of potentiometer
- orientation on a programmable position in relation to the absolute zero based on declared accelerations. (absolute zero too is subject to offset on configuration parameters)
- timing for changing range
- synchronism of more slave spindles with a master spindle
- limit on speeds out of range

The registers for control are all asynchronous (not connected to program blocks or **BURDY**).

Each register must be used with the index relative to the spindle to which refers (for registers of *n* bits a single bit of the register is activated).

All parameters relative to various spindles (range speed, accelerations, transducer types, thresholds) must be written in the system configuration data (see relative documents).

2.1.1. SIGNALS AND REGISTERS FOR SPINDLE ROTATION

SPVEL() (setting of rotation speed).
The required speed in rpm must be placed in this register. If the requested speed is greater then the maximum permissible value, it is automatically reduced.

SPSSO() ((Potentiometer override).
It is possible to regulate the speed between 0 and 200% of the given speed by choosing a value on this register between 0 to 2 (with respect to the maximum speed range).

SPDIR() (Spindle rotation direction).
If the signal is to 0 after a rotation command the referred analog output will be positive. If equal to 1, negative.

SPROT (Rotation command).
The rotation command parameters are provided by the first 4 bits (one for each spindle) of the byte format register.

SPREG (Speed rate reached).
The first 4 bits of this register (one for each spindle) are set high by the **NC** when the theoretical acceleration ramp has been reached and the actual spindle speed is within the specified percentage in the configuration data table. If the requested speed is less than the threshold in the configuration table, the signal is always equal to 1.

SPMOT (Operating spindle).
The first 4 bits of this register (one for each spindle) are set high by the **NC** when the spindle speed exceeds the specified threshold. This signal is always updated, even if the spindle is not selected.

SPRMP (Spindle on ramp).
The first 4 bits of this register (one for each spindle) are activated by **NC** when accelerating or decelerating. Typically used when waiting for spindle stop and start.

SPSGL (Effective threshold speed).
The first 4 bits of this register (one for each spindle) are set high by the **NC** when the actual spindle speed is in tolerance. When the spindle is stationary the signal is 0. It is always active for spindle speeds less than the threshold.

2.1.2. SIGNALS AND REGISTERS FOR RANGE SELECTION

SPGAM() (Given range number).
With a value of between 1 and 4 in this register, the range parameters in the configuration table are activated. With **SPGAM(n)** = 0 neutral is enabled, i.e. the reference command is forced to 0 **V** regardless of the selected rotation.

SPPND Timing command).
The first 4 bits of this register (one for each spindle) activates the timing of the spindle in relation with the machine parameters.

The configuration values for the four speed ranges are read-only on the registers indicated below. They are commonly used for the determination of the physical range to be used during an automatic change.

SPSMG1() Maximum speeds in range 1 for the spindles (1..4)

SPSMG2() Maximum speeds in range 2 for the spindles (1..4)

SPSMG3() Maximum speeds in range 3 for the spindles (1..4)

SPSMG4() Maximum speeds in range 4 for the spindles (1..4)
SPSMAX() Maximum absolute speeds for the spindles (1..4)

2.1.3. SIGNALS AND REGISTERS FOR SPINDLE ORIENTATION

SPORI (Orientation request).

By setting the first 4 bits (one for each spindle) of this register, the spindle orient request **SPPOS** is provided. If transducer has not been referenced to the electrical zero, a zeroing cycle is automatically performed.

SPTOL (Spindle orient in position tolerance).

The first 4 bits of this register (one for each spindle) are activated by the **NC** when a spindle orient command is present and the spindle is positioned in tolerance. To ensure accurate spindle positioning the orientation command should not be reset by the PLC until the **SPTOL** signal is stable.

SPPOS() (Orientation position).

This register will contain the spindle orient position.

Example: SPPOS(1)=(NGRADI // 360)/360

SPVEOR() (Speed limitation in orientation).

The value in this register allows you to limit the spindle speed during orientation. The speed limit is given by:

(1-SPVEOR) x SPSMGx. (SPVEOR = **0** does not give any reduction).

Absolute position orientation

SPOAB (Selection for orientation on absolute values).

If this bit is set (bit 1-4 of the variable, for spindles 1-4) the orientation position value given to **SPPOS()** will be interpreted as an absolute value (including revolutions).

Unidirectional Orientation

To enable unidirectional orientation the bit for the selected spindle must be set in one of the two direction registers **SPORP** or **SPORM.** Load the **SPPOS()** then activate the orientation by setting **SPORI**.

SPORP Orientation in positive direction.

SPORM Orientation in negative direction.

2.1.4. SIGNALS AND REGISTERS FOR SYNCHRONIZED SPINDLES

SPSYN (Spindle synchronism with slave).

With the first 4 bits (one for each spindle) of this register you synchronize the spindle ***n*** with the master in **SPMAS(n)**.

SPSYN synchronization can be obtained at any time. The slave spindle will adjust its speed (even from zero) as a function of the velocity of the master and the speed ratio (**SPRTO**)

keeping the synchronization specified with the **SPOFS** offset. This will work only if the speed ratio for synchronization is an integer.

All the parameters relative to the slave spindle to be synchronized must be set when the slave spindle is not in motion. If a command (**SPROT, SPORI, ...**) is given to a synchronized slave spindle it is automatically uncoupled.

SPMAS() (Master spindle numbers).
To synchronize a slave spindle with a master spindle the number of the master must be entered in the relevant spindle register.

SPOFS() (Synchronism offset).
These registers will contain the rotational offset between the master spindle and the slave spindle (1 = 360 degrees) to be maintained whiled synchronized. The synchronization ratio **SPRTO** must be an integer.

SPRTO() (Speed ratio for synchronism).
These registers hold the ratio between the slave spindle speed and the master spindle speed to be maintained while synchronized (Slave velocity / Master velocity).

SPAGG (Slave spindle synchronized with the master spindle).
The first 4 bits of this register (one for each spindle) are set by the **NC** after synchronization is achieved following the command.

2.1.5. SIGNALS AND REGISTERS COMMON TO ALL SPINDLE TYPES

The commands previously described are prioritized as follows:

1. ***SPPND*** (timing command) *highest priority*
2. ***SPROT*** (rotation)
3. ***SPORI*** (orientation)
4. ***SPSYN*** (synchronization with slave) *lowest priority*

The registers and signals in common with all function modes are the following:

SPMOV (Spindle enable).
The command given by the **NC** on the first 4 bits (one for each spindle) to enable the spindle this command is maintained automatically until the spindle is stopped. It is also maintained during rotation cycles, synchronism and when orientation or timing commands are present. Further protection or any time delays must be implemented by the PLC.
Note: the writing on the channel of analogic reference associated to a spindle is possible only if ***SPMOV*** is absent and if ***SPDIS*** is active.

SPDIS (Spindle disable).
With this command on the first 4 bits of this register (one for each spindle) the PLC requests the immediate disabling of the spindle (the reference is forced to 0 V and the spindle is disabled instantaneously). This signal is used in case of an emergency

SPDRQ (Disabling the spindle transducer).
This command disables the spindle transducer. When disibled the position no longer read and any transducer errors no longer read, transducer zeroing is lost (**SPMZA**).

SPTCH() (Effective spindle speed).
The spindle speed determined by the transducer, is read directly in rpm on each register.

PASP() (Absolute angular position of the spindle).
The transducer must always have a mechanical ratio of 1:1 with the spindle. The range of this register is +131071.9999, -131071.9999.

SPMZA() (Referencing of spindle transducer).
When the spindle transducer has been zeroed (electrical zero) the bit for the relevant spindle is set high. Referencing is automatically executed on the first orientation or request of synchronism.

If it is required to repeat the transducer referencing cycle all that is required is to reset the relevent spindle bit on **SPMZA**.

SPMKS (Zero marker).
This signal is set by the leading edge of the transducer zero signal. This signal has a duration equal to one system cycle. A typical application is to verifiy the transducer function.

NEW VARIABLES

Variables for debugging and calibration:

Name	*Size*	*Direction*	*Description*
SPRIF()	64	NC ⇒ PLC	Speed command sent to the spindles (1..4) [revs/min] can be used to check the acceleration/deceleration ramps by comparing **SPRIF** with **SPTCH** (actual speed) for spindles with transducer.

Variable **SPAGP** has been added for use in diagnostics, it assumes the following significance depending on which type of spindle transducer is used:
With RESOLVER, it represents the transducer analog signal level.
With ENCODER, it represents the number of pulses lost and recovered (with the parameter **STEP RECOVERY ACTIVE**).

Name	*Size*	*Direction*	*Description*
SPAGP()	8	NC ⇒ PLC	Transducer level or pulses lost and recovered for the spindles (1..4).

2.1.6. SPINDLES WITH OR WITHOUT TRANSDUCERS

If the spindle has no transducer **SPTCH** is a calculated speed and **SPSGL** will always be 1, while **SPREG**, **SPMOT** and **SPRMP** are active but in relation with the commanded speed not the actual speed.

In this case the synchronization with other spindles is not possible.

*Where a spindle is equipped with a transducer and the various cycles are functioning correctly, it is absolutely necessary that positive transducer direction (**PASP**) corresponds to a positive analog reference.*

For the orientation cycles to function correctly as well as those functions that require knowing the actual spindle speed one revolution of the transducer must always be equal to one spindle revolution, particularly on lathes.

2.1.7. NOTES ON THE FIXED CYCLE G84

For the G84 fixed cycle with a transducer it is necessary to specify using the **SPGDA** variable, which one of the four possible spindles is synchronized with the master spindle axis.

If the fixed cycle starts but does not proceed it is necessary to check that the transducer has been referenced, i.e. that **SPMZA** is set and that the real speed has reached the nominal value (**SPREG**).

FHOLD, **DHOLD** or **RHOLD** are executed only at the end of the current fixed cycle.

Inputting spindle number = 0 in the configuration parameters causes the NC to start the M3 and M4 functions automatically reversing spindle of rotation at the beginning and at the end of the hole.

Related signals and registers

Spindle Rotation

SPVEL()	64	NC ⇦ PLC	no	Speed spindle(s)(1..4).
SPSSO()	64	NC ⇦ PLC	no	Override potentiometer spindle(s)(1..4).
SPDIR()	8	NC ⇦ PLC	no	Rotation direction spindle(s) (1..4).
SPROT	8	NC ⇦ PLC	no	Comand spindle(s) (1..4).
SPREG	8	NC ⇨ PLC	no	Spindle(s) (1..4) upto speed.
SPMOT	8	NC ⇨ PLC	no	Spindle(s) (1..4) in motion.
SPRMP	8	NC ⇨ PLC	no	Spindle(s) (1..4) ramp upto speed.
SPSGL	8	NC ⇨ PLC	no	Effecttive speed within threshold spindle(s) (1..4).

Range change selection

SPGAM()	8	NC ⇦ PLC	no	Range selected (0 = neutral) spindle(s) (1..4).
SPPND	8	NC ⇦ PLC	no	Hunting command for range change spindle(s) (1..4).
SPSMG1()	64	NC ⇨ PLC	no	Maximum speed for range 1 spindle(s) (1..4).
SPSMG2()	64	NC ⇨ PLC	no	Maximum speed for range 2 spindle(s) (1..4).
SPSMG3()	64	NC ⇨ PLC	no	Maximum speed for range 3 spindle(s) (1..4).
SPSMG4()	64	NC ⇨ PLC	no	Maximum speed for range 2 spindle(s) (1..4).
SPSMAX()	64	NC ⇨ PLC	no	Maximum speed for spindle(s) (1..4).

Spindle orient

SPORI()	8	NC ⇦ PLC	no	Orient command spindle(s) (1..4).
SPTOL	8	NC ⇨ PLC	no	Oriented within tolerance spindle(s) (1..4).
SPPOS()	64	NC ⇦ PLC	no	Orient position spindle(s) (1..4).
SPVEOR()	64	NC ⇦ PLC	no	Speed reduction (from 0 to 1) during orientation spindle(s) (1..4).
SPOAB	8	NC ⇦ PLC	no	Orientation using absolute values spindle(s) (1..4).
SPORP	8	NC ⇦ PLC	no	Unidirectional positive orientation.
SPORM	8	NC ⇦ PLC	no	Unidirectional negative orientation.

Synchronization between spindles

SPSYN	8	NC ⇦ PLC	no	Synchronism command to slave spindle.
SPMAS()	8	NC ⇦ PLC	no	Master spindle numbers for synchronism with slave.
SPOFS()	64	NC ⇦ PLC	no	Offset between master spindle and slave.
SPRTO()	64	NC ⇦ PLC	no	Speed ratio for sync. between master spindle and slave(s).
SPAGG	8	NC ⇨ PLC	no	Slave spindle(s) (1..4) synchronized with master.

Common to all operations

SPMOV	8	NC ⇨	PLC	no	Request to move spindle(s) (1..4).
SPDIS	8	NC ⇦	PLC	no	General disable command spindle(s) (1..4).
SPDRQ	8	NC ⇦	PLC	no	Disable transducer spindle(s) (1..4).
SPTCH()	64	NC ⇨	PLC	no	Effective speed spindle(s) (1..4).
PASP()	64	NC ⇨	PLC	no	Angular position from transducer(s) (1..4).
SPMZA	8	NC ⇔	PLC	no	Transducer(s) referenced to electrical zero. Can be reset to repeat the zero search.
SPMKS	8	NC ⇨	PLC	no	Encoder(s) marker pulse spindle(s) (1..4).

Fixed cycle G84

SPGDA	8	NC ⇦	PLC	no	Spindle to used for fixed cycle G84 with transducer.

2.2. INDEPENDENT AXIS MOVEMENT MODULE

The **independent axis movement module** must to be used in all cases where it is necessary to position an auxilliary axis. That is an axis independent from the NC interpolated axes (tool change, pallet change, etc). The module consists of a point to point type positioning algorithm, interfaceable with minimum programming to the machine logic program (up to a maximum of 8 axes).

For this type of axis reading the transducers and updating the reference is executed every 10 msec or more, depending on the configuration parameters.

The parameters for these modules must be written in the configuration data just like any other axis controlled by the machine. However, parts of this data can be read and re-written through the PLC registers.

The registers available are all asynchronous with the same operations as that of the control axes, i.e not bound by the program blocks or the **BURDY** signal.

Every register must be used with the auxilliary axis index to which it is referred.

Related signals and registers

MOVP2P	8	NC ⇨	PLC	no	Request to enable movement axes (1..8).
RDMP2P	8	NC ⇦	PLC	no	Movement enabled axes (1..8); response to ***MOVP2P***.
SSAP2P	8	NC ⇦	PLC	no	Axes that must be enabled at all times (1..8).
DSVP2P	8	NC ⇦	PLC	no	Axes to be freed (1..8).
DRQP2P	8	NC ⇦	PLC	no	Command to disable the transducers on axes (1..8).
MVMP2P	8	NC ⇦	PLC	no	Axes that may be selected in manual mode (1..8).
MRKP2P	8	NC ⇦	PLC	no	Axes selected to be homed without reference switch (1..8).
MCZP2P	8	NC ⇦	PLC	no	Axes selected to be homed with reference switch (1..8).
MIZP2P	8	NC ⇦	PLC	no	Reference microswitch for axes (1..8).
MZAP2P	8	NC ⇨	PLC	no	Axes referred to transducer zero then repositioned after homing (1..8).
POTP2P()	64	NC ⇦	PLC	no	Speed regulation potentiometer for axes (1..8). From 0 to 100 percent of the speed if in automatic, or of the acceleration, if in manual.
JGPP2P	8	NC ⇦	PLC	no	Comand JOG positive axes (1..8).
JGMP2P	8	NC ⇦	PLC	no	Comand JOG negative axes (1..8).
PFNP2P()	64	NC ⇦	PLC	no	Automatically move to programmed position axes (1..8).

RUNP2P	8	NC ⇦ PLC no	Positioning commands in automatic for axes, (1-8). They must be set by the PLC to command the movement to the set position; they are reset by the NC when the axis, having ended the movement, enters the in position threshold set in configuration data.
RHDP2P	8	NC ⇦ PLC no	HOLD request, axes (1..8). Temporary hold of movement; the operation continues without further commands as soon as axes are released.
HDAP2P	8	NC ⇨ PLC no	HOLD request, axes (1..8). Temporary hold of movement; the operation continues without further commands as soon as axes are released.
RBKP2P	8	NC ⇔ PLC no	BREAK request on movements in automatic, axes (1..8). **RBKP2P** is reset by the NC when acquired. The axes are decelerated to a stop, and the **RUNP2P** is reset. In emergency state (**EMAP2P**) it is used to cancel the emergency but only if the request has been removed (**REMP2P**).
BKAP2P	8	NC ⇔ PLC no	Axes not in motion following a **RBKP2P** command (1..8); they can be reset by the PLC, but this is not binding.
REMP2P	8	NC ⇨ PLC no	Request to go to an emergency state axes (1..8).
EMAP2P	8	NC ⇨ PLC no	Axes in emergency state. Going in to this state, the axes are disabled immediately without a controlled deceleration (1..8).
POAP2P()	64	NC ⇨ PLC no	Absolute position read from transducer axes (1..8).
TCHP2P()	64	NC ⇨ PLC no	Effective speed (from transducer) axes (1..8).
SGLP2P	8	NC ⇨ PLC no	Axes within positioning tolerance set in the configuration (1..8).
MKSP2P	8	NC ⇨ PLC no	Marker pulse (electrical zero) for axes (1.8) with encoder or optical scales.
FCPP2P	8	NC ⇨ PLC no	Axes(1..8) where actual value results are greater than the positive travel limit set in the configuration.
FCMP2P	8	NC ⇨ PLC no	Axes(1..8) where actual value results are greater than the negative travel limit set in the configuration.
VATP2P()	64	NC ⇨ PLC no	Theoretical speed (computed) axes (1..8). If in the configuration data it is declared that the D/A converter is not present the reference in voltage will not be sent through the output channel, but the speed in this register is always available.
JINP2P	8	NC ⇨ PLC no	Axes (1..8) in motion after a ***JOGP2P*** **command**.
DIRP2P	8	NC ⇨ PLC no	Axes (1..8) motion direction (revealed by the analog reference sign). The value 1 means negative speed.

The following registers are initialized on startup with the values in the configuration table, subsequently the PLC may read and modify them as long as the axis is not moving.

FEDP2P()	64	NC ⇔ PLC no	Feed speed, axes (1..8).
RAPP2P()	64	NC ⇔ PLC no	Rapid speed, axes (1..8).
VLNP2P()	64	NC ⇔ PLC no	Slow zone speed, axes (1..8).
ZLNP2P()	64	NC ⇔ PLC no	Slow zone distance, axes (1..8).
DEXP2P()	64	NC ⇔ PLC no	Exponentional deceleration distance, axes (1..8).
ACMP2P()	64	NC ⇔ PLC no	Acceleration in manual, axes (1..8).
ACCP2P()	64	NC ⇔ PLC no	Acceleration in automatic, axes (1..8).
DECP2P()	64	NC ⇔ PLC no	Deceleration from feed speed to slow speed, axes (1..8).
DE2P2P()	64	NC ⇔ PLC no	Exponential deceleration from slow speed, axes (1..8).
TOLP2P()	64	NC ⇔ PLC no	Positioning tolerance, axes (1..8).
OFSP2P()	64	NC ⇔ PLC no	Transducer offset applied to the reading to obtain the absolute value ***POAP2P()*** (1..8).

NEW VARIABLES

Variables for debugging and calibrating axes:

Name	*Size*	*Direction*	*Description*
SHIP2P()	64	PLC ⇒ NC	Origin shift for independent axes (1..8). Allows definition of a zero position different from the absolute zero. The final positions of **PFNP2P()** are always referred to **POOP2P()**.
POOP2P()	64	PLC ⇒ NC	Independent axis position (1..8) affected by the origin shift **SHIP2P()**.

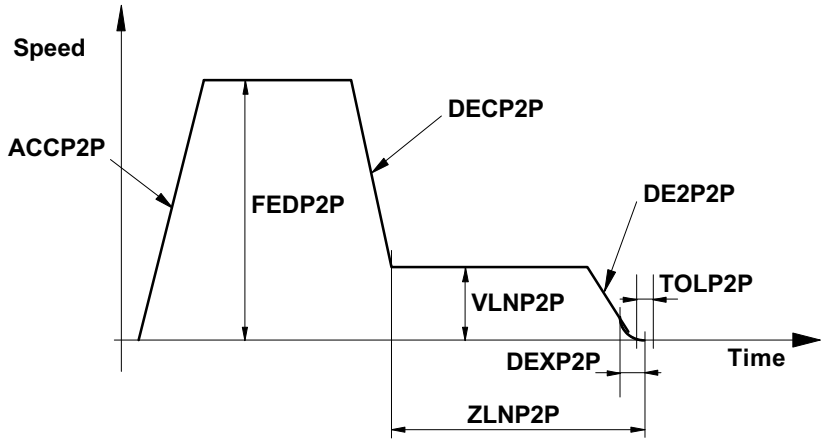
Notes for use

The speed diagram for axes is shown below.

To eliminate the slow speed section (**ZLNP2P**) the value should be set to 0 in the initialization parameters.

The control is point to point. Axis movement is independent of other axes and the commanded speed depends on the distance to the final point with respect to the accelerations and speed limits set in the configuration parameters therefore there will be no following error for the controlled axes.
To control the axis speed, it is necessary to compare the real speed **VATP2P** with the effective speed **TCHP2P**.

Independent axis speed diagram



2.3. TOOL CHANGER CONTROL MODULE

Tool change management (abbreviated TC) is simplified by the presence of an integrated module with a reduced number of variables.

The TC type must be input in the NC configuration and after decoding a ***T*** or ***M6*** function will be activated by the PLC.

TC main uses are:

- Seeking the **SEQUENCE** (load, unload, exchange, from storage or from the floor) for the requested tool by analyzing the storage and spindle situation, tool table, change type configuration and explicit load/unload requests.
  Each **SEQUENCE** is then identified by a number, for example sequence 6 = tool change between spindle and storage.

- Management of the tool table and the finding of the positions of tool pick-up and return.

- Management of the different tool sizes.

- Management of the same tool family.

- Simplify the sequence execution through the right integrated sequencer.

The application does not necessarily need to manage all the **SEQUENCE** possibilities, but only those considered necessary according to the type of machine and the complexity required.

They must be defined in the PLC program, indicating for each one all the **OPERATION CODES** (elementary actions) to physically initiate the exchange (for example: operation 9001 = tool disengagement, operation 9021 = open changer arm jaws). They must be indicated next to the internal codes, necessary for updating the sequence in the tool table.

At the time of the sequence execution, the relative codes of **OPERATION** are sent to the PLC in the defined order. The latter must mainly manage the mechanical operations controlling the change, search and carry out the single simple physical operations without being overloaded by the management of the tool table, tool sizes, tool family or the sequence of load, unload or change.
That means that the management of the TC sequencer must be similar to the *M*, *H* auxiliary common functions.

2.3.1. SIMPLE DEFINITIONS

OPERATION: is the code of a basic action that the TC module sequencer communicates to the PLC. Every basic action must not have similar sequences with the others.

SEQUENCE: is the arranged series of OPERATIONS that the TC module must execute in function of the actual state of the storage, tool table, etc...

JAWS: are the gripper part of the arm to remove the tool from the spindle or in the case of an intermediate station the exchange arm.

INTERMEDIATE STATION: a secondary tool station to hold the next tool to be used.

When it is necessary to differentiate the tools by different types and sizes, the following must also be considered:

TOOL TYPE:
- **normal tool:** used with the selected TC type in a coherent manner (random or fixed position).
- **special tool:** only and always used as a fixed position tool: it will be returned to the same position as picked up.

TOOL SIZE: normal and special tools can be of the following sizes:
- **small tool:** always occupies the one position in storage**.**
- **medium tool:** occupies the number of positions in storage
- **large tool:** declared in the configuration.
- **extra tool:**

2.3.2. TYPES OF TOOL CHANGER CONFIGURATION

The main chioce in the configuration is the form of the TC operation :

MANUAL TYPE S1200: PLC control is not necessary to activate tool compensation and a program in execution break is automatically generated for every ***T*** with a value from 10 to 98.

Any ***T*** from ***T0*** to ***T9*** are origin parts. ***T99*** forces the absolute origin, every other ***T*** exits this state.

MANUAL: PLC control is not necessary to activate tool compensation and a program in execution break is automatically generated for every ***T*** operation.

The origin parts are managed separately with the ***O*** operations.

The ***O0*** code, eliminated by every other ***O***, allows the passage to absolute origin.

The ***O-1*** code allows the present origin to be reactivated before passing into the absolute origin.

The ***T0*** operation cancels the active length correction.

AUTOMATIC: The ***T*** operation code is sent to the PLC, but does not generate any program break or activate any correction. The PLC program must activates the TC module, except for particular situations.

The part origins are managed separately with the ***O*** oodes.

The ***O0*** code, cancelled by every other ***O* code**, sets the part origin to absolute.

The ***O-1*** code allows the present origin to be reactivated before passing into the absolute origin.

The activation of OFST = 0 cancels the active length correction.

2.3.3. CONFIGURATION OF AUTOMATIC TOOL CHANGER

The choices relative to the storage configuration and the positions occupied for the different tool sizes that must be set in the configuration, are summarized in the following:

Tool Disposition

fixed position: Every tool is placed in storage in the position corresponding to its own code. Its position remains unchanged during the running of the machine every tool will always be restored to the position from which it was taken

random position: Prior to this there are no bonds between the tool code and the spot it occupies but a precise storage position inside the tool table is assigned to every tool this will never be changed during the operation of the machine.

random: None of the tools have pre-assigned specific positions, they are picked up and replaced in a way to optimize the order in storage and the time of tool change.

Tool storage geometry

chain: Presumes a consecutive order of the tool locations that is in which the dimensional limits are to be considered only against the preceding and subsequent tool.

Plane: Presumes a tool order in a storage according to a regular **XYZ** grid aligned with the axes.

For this tool change type management by size is not expected (typically the tools are placed into the storage from above and therefore they must be of the **small** type).

Types of tool storage management

synchronous: *The tool search can not be done in masked time* working simultaneously with the NC processing. As the intermediate station for the exchange is not present (the tool change will begin with the return of the old tool before, searching for the new one).

Asynchronous*:* *The tool search can be done in masked time*, working simultaneously with the NC program, as a tool change arm exists between tool storage and spindle with a JAW and an INTERMEDIATE TOOL STATION.

Semiasynchronous: In the current types of automatic tool changers with **RANDOM** disposition of the tools, often the **intermediate station** is missing; the programming of the Txx function generates only a rotation of the magazine without changing the situation of the tools.In these cases, the **Semiasynchronous** storage management type may be used**.**

2.3.4. SEQUENCE DEFINITIONS

Every TC SEQUENCE must be defined with mandatory codes in the PLC program and identified with negative numbers. These codes are necessary for the updating of the tool table, they must be in a specified sequence as described on the following pages.

In addition all the OPERATION codes considered necessary by the PLC, may be inserted using whole numbers between 1 and 32767.

The following are the meanings of the pre-defined OPERATION internal codes:

-1 New tool picked up from storage requested by the station
-4 New tool picked up from storage and inserted in the spindle
-5 New tool picked up from storage and inserted in the intermediate station
-6 Tool change wait operation (**M6**)
-10 Old tool manually extracted from the spindle and laid down on the ground
-12 Old tool extracted from the spindle and inserted into the jaws
-13 Old tool extracted from the spindle and placed in storage
-16 New tool picked up and inserted manually in the spindle
-17 New tool extracted from intermediate station and inserted in the spindle
-23 Old tool return requested by the station
-27 Old tool extracted from the jaws and returned to storage
-31 Tool extracted from the intermediate station and returned in storage
-34 Tool change end sequence
-0 Situation analysis request for beginning a new sequence

Not all sequences, described above, have to be defined.

Those required to be defined because of the the characteristic of the machine and the complexity required by the operation, must be set in the INIT section of the PLC through the instruction:

DEF SEQCU(seq. number) = predefined code, PLC code, ... others [,COM,1,'prog. name']
carrying all the pre-defined internal codes in the order provided.

Definition errors in the sequence are signaled on the screen. Besides the operation codes it is possible by using the instruction **DEF SEQCU(n)** to specify a NC sub-program name (**COM, 1, 'prog. name'**) that will be automatically executed in conjunction with **M06** (-6) awaiting operation and the PLC signal of the programmed **M06** (**M6PGM = 1**) for positioning the NC axes and executing the tool change sequence in non masked time.

According to the configured automatic tool change, the possible SEQUENCES are shown below.

*In every sequence that requires the insertion of a new tool in the spindle, it is necessary to activate the tool length compensation before initiating the work (**INTOF = 1**).*

Asynchronous tool changes

Management sequence for placing tools on the ground (with POSIZ. MAGAZ. = 0 and SELECU = 0 or SELECU=1):

Sequence 1: -6, -16, -34	pick up tool and insert in the spindle (loading)
Sequence 2: -6, -10, -34	remove tool from spindle (unloading)
Sequence 3: -6, -10, -16, -34	remove tool from spindle, pick up and insert in spindle (exchange)

Exchange sequences between tools from the floor and tool storage (SELECU = 0)

Sequence 4: -1, -5, -6, -10, -17, -34 unload tool from spindle to floor, pick up tool from storage and place in spindle
Sequence 5: -23, -6, -12, -16, -27, 34 unload tool from spindle to storage, load tool from floor to spindle

Sequences of tools from tool storage (SELECU = 0)

Sequence 6: -1, -5, -6, -12, -17, -23, -27, -34 place spindle tool in storage, pick up from storage and place in spindle (exchange)
Sequence 7: -1, -5, -6, -17, -34 pick up tool from storage and place in spindle (loading)
Sequence 8: -23, -6, -12, -27, -34 return tool from spindle to storage (unloading)

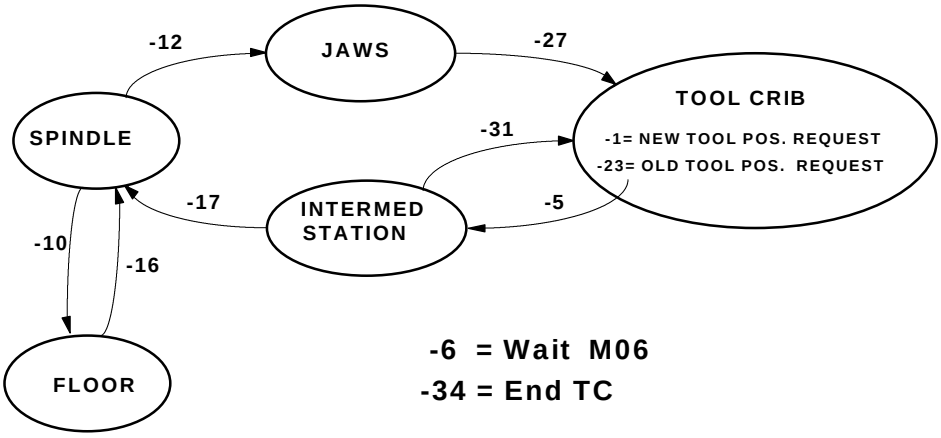
Others sequences (**SELECU** = 0)

Sequence 11: -6, -34 same as above (changer correction)
Sequence 19: -23, -31, -0 tool lay down from intermediate station to storage and new operation analysis (two consecutive **T**'s).

Load and unload sequences, tools from floor to storage through spindle

(only with **SELECU** = 2):
Sequence 9: -23, -6, -16, -12, -27, -34 tool pick up from floor to spindle, from spindle to jaws return to storage.

(only with **SELECU** = 3):
Sequence 10: -1, -5, -6, -17, -10, -34 tool pick up from storage in intermediate station tool pick up from intermediate station to spindle, return from spindle to floor.



Synchronous tool changes

Management sequence of tools on floor (with POSIZ. MAGAZ. = 0 and SELECU = 0 or SELECU=1):

Sequence 1: -6, -16, -34 pick up tool and place in spindle
Sequence 2: -6, -10, -34 remove tool from spindle (unloading)
Sequence 3: -6, -10, -16, -34 remove tool from spindle, pick up tool and place in spindle (exchange)

Exchange sequences between tools on floor and tool storage (**SELECU** = 0)

Sequence 4: -6, -10, -1, -4, -34 place spindle tool on floor, pick up tool from storage and place in spindle
Sequence 5: -6, -23, -13, -16, -34 return tool from spindle to storage, pick up tool from floor and place in spindle

Sequences of tools from tool storage (SELECU = 0)

Sequence 6: -6, -23, -13, -1, -4, -34 return tool to storage, pick up tool from storage and place in spindle (exchange)
Sequence 7: -6, -1, -4, -34 pick up tool from storage and place in spindle
Sequence 8: -6, -23, -13, -34 return tool to storage (unloading)

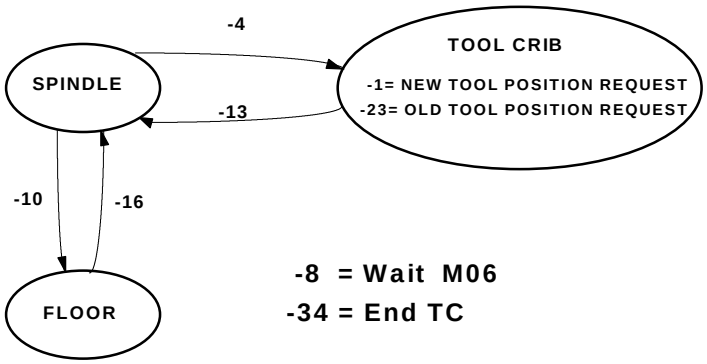
Other sequences (SELECU = 0)

Sequence 11: -6, -34 same as above (changer corrector, execute INTOF = 1 in synchronous mode).

Load and unload sequences, tools from floor to storage via spindle

(**SELECU** = 2):
Sequence 9: -6, -16, -23, -13, -34 load tool in spindle, return from spindle to storage

(**SELECU** = 3):
Sequence 10: -6, -1, -4, -10, -34 tool in spindle from storage, unload from spindle to floor.



Semiasynchronous tool changes

This configuration has the following characteristics:

- Physically no intermediate station exists, the gripper and intermediate station cells have non significance in the tool table and are therefore not managed.
- Updating of the tool table has been considerably simplified: even in the change cycle interruption stage, the only tool to have the "-" (minus) sign is the one in the spindle.
- A requirement of the semiasynchronous tool change is that the operation of depositing the old tool is always simultaneous with that of taking the new tool (by means of a two-gripper exchanger arm); as a result, the pick and place positions must be coincident.
- The case of an exchange of tools of different sizes has been made different from the exchange between tools of similar sizes to facilitate coding of the PLC.

The significance of the internal codes of the predefined OPERATIONS is as follows:
- 9 Exchange of tool between spindle and storage

Sequences for management of tools on floor (manual)

Sequence 1:	-6, -16, -34	load from floor to spindle
Sequence 2:	-6, -10, -34	unload from spindle to floor
Sequence 3:	-6, -10, -16, -34	exchange between spindle and floor

Sequences for exchange between tools on floor and storage (mixed) (SELECU=0)

Sequence 4:	-1, -6, -10, -4, -34	return spindle tool to floor and pick from storage
Sequence 5:	-23, -6, -13, -16, -34	return spindle tool to storage and pick from floor

Sequences for management of tools from storage (automatic) (SELECU=0)

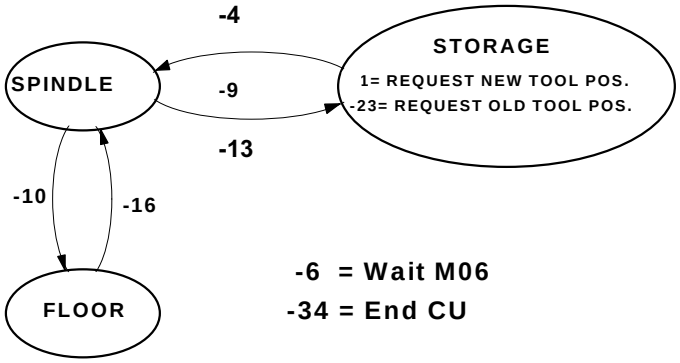
Sequence 6:	-1, -6, -9, -34	tool exchange between storage and spindle (same size)
Sequence 13:	-23, -6, -13, -1, -4, -34	tool exchange between storage and spindle (different size)
Sequence 7:	-1, -6, -4, -34	load tool from storage to spindle
Sequence 8:	-23, -6, -13, -34	unload tool from spindle to storage

Other sequences (SELECU=0)

Sequence 11:	-6, -34	programmed tool same as tool in spindle (only change Length corrector)

With this type of tool change, the Sequence 13 (exchange of different sizes) can be implemented at least with one of the following methods:

- Double exchange: first and foremost, the storage is put in the deposit position, which must be empty (operation –23); when the M6 is executed, there is then a first exchange between the tool in storage and the spindle (after this operation, the spindle remains empty and the arm returns to rest); the cycle continues with the magazine being put in the position to pick up the new tool; and finally the cycle is completed with a further exchange between storage and spindle.
- Single exchange: the Sequence is conducted like a normal type, same size exchange, but when both tools are found in the grippers of the exchanger arm (typically arm down) the magazine is rotated to the deposit position.



PLC program implementation

Example: ASYNCHRONOUS RANDOM CHAIN TC

INIT
DEF SEQCU(6)=901,-1,902,920,-5,-7,...,COM,1,'SCAMBIO' [tool change with storage
[901 = storage clearing for rotation
[-1 = pre-defined code: sets the storage in pick up position
[902 = storage lock
[920 = exchanger arm in grasp/release position
[-5 = pre-defined code: new tool taken from storage and inserted in intermediate station
[-6 = pre-defined code: wait M06
[COM,1,'CHANGE' = NC sub-program to run on -6 operation, when M06 is programmed (M06PGM=1)
PROG
...

Activation of tool changer module

The PLC synchronously receives the new code of the programmed **T** operation on the **TOOL** register with the **STROT** strobe but that does not yet activate the TC module.

To activate the TC module the tool code must be written in the **UTECU** register and the **NEWCU** signal set. This is reset by the TC as soon as the particular sequence for the requested tool change has begun on condition that the **MAPRCU** signal is equal to 1.

Naturally the tool table must have been already compiled.

UTECU = 0 is understood as a down tool return request from spindle to storage or on the floor if no space is available.

Actuation of the sequencer

The TC module sets the **CUATT** (active tool change) signal after being activated (**NEWCU** reset), then:

- sends to **NSEQCU** register the operating SEQUENCE number
- sends to **PPRECU** register the storage position number of new tool
- sends to **PPOSCU** register the storage position number for old tool

- prepares on **OFST** register the corrector code associated to the new tool
  at the end it sends to the PLC, on the **OPERCU** register, the sequence defined in **DEF SEQCU(n)**, the operation codes accompanied by a strobe **BRDYCU**.

The PLC must take care to run the proposed single operation without interfering with the others. The only expected bonds are of mechanical nature and of security between one changer and another.

The synchronism signal of the **BRDYCU** communication must be reset by the PLC as soon as the new operation is acquired.

If the required operation requires a pause to execute the next phase the PLC must temporarily set the **MAPRCU** signal to zero (machine ready for the TC). Normally MAPRCU is 1.

In cases in which the present operation is a pick-up/lay down station request the PLC must set the storage as a function of the indicated positions of the **PPRECU** and **PPOSCU** using if necessary, the INDEPENDENT AXES MOVEMENT MODULE.

When the sequence arrives to the -6 operation (wait for M06) it pauses automatically and waits until the PLC activates the M6PGM signal **(**M06 programmed).

When the TC module while in the wait mode **M06 (-6**) receives the **M6PGM** signal it runs the NC sub-program (COM) defined for the present sequence. Afterwards the M6PGM is reset and the TC sequence continues with the following phases.

The NC sub-program runs the operation sequences in synchronous mode. Tool change and the NC axes positioning.

It is important to notice that the active M6PGM signal will automatically pause the program thus preventing the PLC program from running complex synchronizing functions. Consider the case in which the M6 operation is run before the tool specified by the T operation is available from storage, since the search is still in progress (random TC).

The current TC sequence is terminated when the PLC resets the CUATT signal, since the TC (-34) end operation has been executed.

The NEWCU tool change request is acquired only if:

- the TC has no sequences running.
- if a sequence is running and the M6 wait operation is being executed (the case of two consecutive T codes without **M**6);

In this way it is not necessary for the PLC to execute a complex synchronised program.

If the TC recieves a sequence not declared within the **DEF SEQCU(n**) instruction a message of **sequence not expected**, is displayed for the operator and an emergency tool change state is activated **(EMAC**U = 1 signal). This state does not affect any of the other NC operations.

Tool length correction

To activate tool length correction, ***OFST***, the PLC must execute in synchronous mode with ***BURDY*** and the ***INTOF*** strobe (is reset by the NC).

It is possible to overwrite ***OFST*** before setting ***INTOF*** if a different tool length correction is required.

When managing tools subdivided by group (alternative tools) particular care must be taken. In these cases the tool to be mounted does not necessarily have the same programmed “T” code, so unwanted effects could be obtained by ***OFST*** overwrites.

Decoding the programmed ‘T’ and selecting the work sequence

In order to provide compatibility with the syntax of the S1200 series systems in which the ‘T’ functions from **T**0 to **T**9 represent origin piece and not tool and **T99** represents the position in absolute coordinates. It will be necessary to decode the programmed T before activating the tool change module.

Before starting the TC module, it is possible to choose the operation mode by writing the desired code in the **SELECU** register: The selections run with a TC sequence already in course are ignored.

0 = normal mode (default):
the requested tool is mounted in the spindle by picking it up from storage if present or from the floor.

1 = storage excluded mode:
the tool is mounted in the spindle from the floor and put down. The storage is considered removed from use.

2 = programmed tool with storage load mode:
the requested tool is mounted in the spindle from the floor then placed in storage.

3 = programmed tool with storage unloading mode:
the requested tool is mounted in the spindle from storage if not already present and immediately laid down.

2.3.5. SEQUENCE INTERRUPTION

It is possible interrupt a tool change sequence in two ways:

- instantaneous interruption for emergency. Obtained by setting the ***REMCU*** signal.
  - the TC enters emergency state (***EMACU = 1***)
  -the tool table does not match the real situation therefore it is necessary to have operator verification. Every subsequent tool change request will be ignored.
- sequence interruption with ***RBKCU*** signal: ***EMACU*** is not signaled.

If the TC is turned off (power loss) during a tool change sequence at the next re-start a clear message is displayed and ***EMACU*** is automatically set.

To exit the emergency state the ***REMCU*** request must be removed, then the ***RBKCU*** activated. It is in its turn automatically reset by the TC when acquired. In any case it is necessary to install the securities in the PLC so that any automatic TC sequence can not begin if the initial conditions are not verified (TC pause).

Integrated tool life management

The tool life management algorithm permits checking of the machining time (REMAINING LIFE) of the tool in the spindle by means of a «counter» which is decremented by the CNC every 10mS when the PLC sets the tool flag in the removing stage **UTRUN**.
When the REMAINING LIFE becomes less than the MINIMUM LIFE threshold, the tool is considered expired.
The next time this tool is called up, it may be replaced by an alternative (tool family management).
Where there are no alternative tools (typically with the manual Tool Changer) a tool no longer available message is generated.
For more detailed information, see the *Technical Bulletin number 1 of 1996*.

DESCRIPTION OF THE PLC VARIABLES

Name	*Size*	*Direction*	*Description*
UTRUN1		PLC ⇒ NC	Tool in spindle in work stage: decrement REMAINING LIFE
UTTIM	32	NC ⇒ PLC	Value of the REMAINING LIFE counter for the tool in the spindle.
UTSTS	8	NC ⇒ PLC	Status register of the tool in the spindle: UTSTS (1) = life finished UTSTS (2) = life remaining <= 0

2.3.6. DIFFERENTIATING THE TOOL FAMILY

Management by ‘family’ presumes the existence of technologically equivalent tool series. At program level there exists only one tool (father) and a series of substitutes (children) that will be mounted in its place at the end of tool life, breakage or wear etc. If for example tool T65 has as a father tool T23 then when T23 is requested it will be used as long as possible, then substituted with T65. With this management the PLC does not recognize the tool or the correction to apply.

The choice of the tools in the family is performed as a function of the parameters "life expired" and "excluded tool".

Every tool is characterized by:

- a maximum life represented, in minutes and seconds, of the maximum time of usage
- **a life remaining** that represents the maximum life minus activity time past
- **a minimum life** reached, in which the tool is considered worn

Prohibited tool tool exclusion that has priority over the tool life situation.

At the moment a tool is chosen from a family those ones with life expired and those excluded will be discarded.

2.3.7. DIFFERENTIATING TOOLS WITH DIFFERENT SHAPES

The TC module is capable of managing tools of different sizes (up to 4) transparently without effecting any PLC operation. Tool dimensions must be indicated in the configuration data.

2.3.8. DESCRIPTION OF PLC VARIABLES

UTECU	16	NC ⇦ PLC	no	Tool number request to tool change module**.** **UTECU = 0** is a particular code reserved for the return tool sequence from spindle to storage (or on the floor if no space is available)**.**
NEWCU	1	NC ⇔ PLC	no	New sequ ence activation command for TC. This signal is set by the PLC to activate the tool exchange module and it is reset by the TC as soon as it is acquired**.**
NSEQCU	16	NC ⇨ PLC	no	Last TC code sequence undertaken.
BRDYCU	1	NC ⇔ PLC	no	Strobe of new code presence on **OPERCU**. It is set by TC and must be reset by the PLC as soon as the new operation has been acquired.
MAPRCU	1	NC ⇨ PLC	no	Machine ready for tool change: if equal to 0, the sequence will be suspended until released.
OPERCU	16	NC ⇨ PLC	no	Operation code requested by the TC from the PLC.
PPRECU	16	NC ⇨ PLC	no	New tool pick-up reaching position.
PPOSCU	16	NC ⇨ PLC	no	Old tool return reaching position.
CUATT	1	NC ⇔ PLC	no	TC generated signal when a new sequence initiates, reset by the PLC when the current sequence is considered terminated.
M6PGM	1	NC ⇔ PLC	yes	(M6 programmed) must be synchronized with the BURDY by the PLC, it is reset by the TC when, the M06 wait operation is received and the NC sub-program (COM) has been run. In absence of this signal, the sequence stops on the phase (-6). An active **M6PGM** implicates an automatic suspension of the execution of NC blocks !
UTSPCU	16	NC ⇔ PLC	no	Number of tool in spindle (read only).
UTSICU	16	NC ⇔ PLC	no	Number of tool in intermediate station (read only).
UTPICU	16	NC ⇔ PLC	no	Number of tool in jaws (read only).
EMACU	1	NC ⇨ PLC	no	Tool change in emergency state. This is set when the TC sequence is interrupted by a TC emergency request. The presence of this signal means that the tool information present in the table can not be justified with respect to the real situation. Operator intervention is necessary, any requests for new tool changes, **NEWCU,** are ignored..
REMCU	1	NC ⇦ PLC	no	TC emergency request. This command interrupts the TC current sequence and the running operation, putting the TC in an emergency state.
RBKCU	1	NC ⇔ PLC	no	Exit from the **EMACU** TC emergency state and a tool change sequence interruption request.
SELECU	8	NC ⇦ PLC	no	Form selector. It must be arranged before the tool change module is activated it is acquired at the beginning of the sequence and can not be modified during the same. 0 = TC mode normal 1 = TC mode with storage excluded 2 = TC mode with storage programmed tool load 3 = TC mode with programmed tool lay down
ERCU	16	NC ⇨ PLC	no	Error code displayed by the TC. At every operation the information relative to storage, tool table and configuration is verified. In case the information is not valid or in situations not forseen or not manageable the TC interrupts the active sequence and communicates the error. In addition no TC sequence is operable if it is an error condition.

NEW INFORMATION VARIABLES

The PLC can acquire some configuration parameters to be able to implement more flexible and general programs; the information is available in the following variables:

Name	*Size*	*Direction*	*Description*
CUATYP	16	NC ⇒ PLC	Type of tool changer selected 0 = manual 1 = manual S1200 2 = automatic
MAGGEO	16	NC ⇒ PLC	Selected storage geometry 0 = chain 1 = planar
MAGTYP	16	NC ⇒ PLC	Selected disposition of tools in storage 0 = fixed 1 = random 2 = fixed random
MAGGST	16	NC ⇒ PLC	Selected storage management 0 = synchronous 1 = asynchronous 2 = semiasynchronous

2.3.9. TOOL TABLES

The tool table stores all the information relative to the tools, it is organized line by line arranged and on several pages.

TOOL PARAMETERS (tool table page 1)

- tool codes, radius and length corrections, storage position, status (excluded or not), special types and sizes
- tool codes in spindle, in jaws and intermediate station

TOOL LIFE PARAMETERS (tool table page 2)

- maximum life, minimum life, life remaining, tool father, tool life expired

AVAILABLE APPLICATIONS PARAMETERS (tool table page 3)

- word#1, word#2, float#2, float#3

The valid tool codes are all whole numbers from 1 to 32767.

The position in storage is to be interpreted in the following way:

- if it is a number between 1 and the maximum number of positions for tool storage it represents the position in which the tool must be taken from.
- if it is equal to 0 it means that the tool must be taken from and then manually returned to the floor.
- if it is a number preceded by a negative sign it means that the tool has been taken and it represents the position from where the tool has been taken from (this information is useful in the case of random fixed).

If the exclude state flag is equal to "yes" the corresponding tool will never be mounted it will be treated as if not present in storage (the tool may be declared excluded if its integrity is not verified).

If there is a tool that is not in the exclude state and for which the father is equal to a excluded tool this will be mounted as an alternative.

The tools in which the expired life flag is equal to a "yes" will be treated as excluded tools.
“Father”, as already mentioned indicates tools for which there are alternatives.

Example:
- T10 with expired life no father
- T11 with a life not expired with father 10

T10 is programmed. The first tool found with a life not expired will be mounted and that is tool 11.

The variables **WORD#**1 and **WORD#**2 are two words (RAM,16) available to contain some additional information relative to the tool.

In the same way two variables in floating point format (RAM,32) named **FLOAT#**1 and **FLOAT#**2, are available.

Writing to the tool table from the PLC

(Only for particular applications)

Normally the tool table is completely managed by the tool change module however, for particular applications all the tool table fields are accessible by the PLC for reading and writing.

The reading can be done like any other PLC variable without any particular precaution.

It is necessary to keep in mind that the entries on these variables involve a rather long sequence, besides the table normally present in the working memory of the system, it is also necessary to update the copy in the system static memory. An operation that requires longer update times.

In the PLC are arrays that represent the columns of the tool tables. The values are available in the UTENRI variable with the names shown in succession.

To be able to access to the parameters of a certain tool it is necessary to search with the following instruction:

RIC(UTNUM,1,UTENRI,TOOL) label

As mentioned since writing to the table fields is slow it is not practical to pause the PLC program to wait for the writing operation. Therefore a temporary memory with limited capability (16 lines) exists on which the variables relatives to the fields are temporarily transferred to be written later when time is available.

The amount of temporary memory available is shown in the **UTEFRE** variable. The PLC will must always verify the available memory before updating the table fields. If this rule is not respected the PLC will be deactivated and a message displayed on the screen.

The PLC has also available an additional array **MAGCUA(**) representing an image of the tool storage **(MAGCUA(1**) = position 1 and so on). The number of elements depends on how many positions are defined in the configuration parameters (the PLC can read this number on **MAGNPO**).

Signals and registers summary

UTENRI	16	NC ⇨ PLC	no	Line number in the tool, maximum number of vector elements representing the columns in the tool table.
UTNUM()	16	NC ⇔ PLC	no	Tool codes in the table (1 .. ***UTENRI***).
UTPOS()	16	NC ⇔ PLC	no	Tool storage location (1 .. ***UTENRI***).
UTCAP()	16	NC ⇔ PLC	no	Tool "farthers" (1 .. ***UTENRI***).
UTDIM()	8	NC ⇔ PLC	no	Tool types (1 .. ***UTENRI***), dove: 0 = small 1 = medium 2 = large 3 = extra
UTSPC()	8	NC ⇔ PLC	no	Special tools (1 .. ***UTENRI***) where: 0 = normal tool not 0 = special tool
UTPLKO()	8	NC ⇔ PLC	no	Excluded tools (1 .. ***UTENRI***) where: 0 = tools not excluded not 0 = tool excluded
UTVTKO()	8	NC ⇔ PLC	no	Life expired (1 .. ***UTENRI***) where: 0 = life not expired not 0 = life expired
UTVITA()	64	NC ⇔ PLC	no	MAX tool life (1 .. ***UTENRI***) in 1/100 of a second.
UTVTRE()	64	NC ⇔ PLC	no	Remaining tool life (1 .. ***UTENRI***) in 1/100 of a second.
UTVTMI()	64	NC ⇔ PLC	no	Minimum tool life (1 .. ***UTENRI***) in 1/100 of a second.
UTWD1()	16	NC ⇔ PLC	no	***WORD#1*** - variable 1 for application (1..***UTENRI***).
UTWD2()	16	NC ⇔ PLC	no	***WORD#2*** - variable 2 for application (1..***UTENRI***).
UTFP1()	32	NC ⇔ PLC	no	***FLOAT#1*** - variable 1 (floating point) for application (1 .. ***UTENRI***).
UTFP2()	32	NC ⇔ PLC	no	***FLOAT#2*** - variable 2 (floating point) for application (1 .. ***UTENRI***).
UTEFRE	16	NC ⇨ PLC	no	Number of entries still available in tempory memory for updating tool tables.
MAGNPO	16	NC ⇨ PLC	no	Number of tool storage locations configured in the parameters.
MAGCUA()	16	NC ⇨ PLC	no	Array representing tool storage image (0 .. ***MAGNPO***).

READING AND WRITING OF RADIUS AND LENGTH CORRECTORS

The PLC can have read and write access to the fields that relate to length and radius correction in the tool table using the variables listed below; the mode of access is the same that used for the other tool table access variables. Each element of the arrays corresponds to a line of the tool table. The number of elements in each vector depends on dimensions of the tool table.

Name	*Size*	*Direction*	*Description*
CORR_Z()	32	NC ⇔ PLC	correction of length of tool on spindle axis (or longitudinal for lathes)
CORR_R()	32	NC ⇔ PLC	tool radius correction
CORR_X()	32	NC ⇔ PLC	tool diameter correction (for lathes only)

2.4. SERIAL LINE MANAGEMENT MODULE FROM PLC

The PLC has access to the serial lines of the PC board through a set of dedicated instructions; the description of the syntax of the instructions and of these features has not been included in this documentation for reasons of space: see instead the specific documentation.

3. ADAPTING A PLC PROGRAM FROM S1200 TO S3000

In the following pages are described the main modifications to make PLC programs written for the S1200 system compatable with the language of the S3000 system, without using the new language potential and the INTERNAL MODULES FOR THE MANAGEMENT OF THE SPINDLE, INDEPENDENT AXES AND TOOL CHANGES.

[GENERIC PROGRAM S1200

INP
IMAPR [Machine ready
OUT
ABX [enable X axis

[******** DECLARE VARIABLES **************
RAM,32 [variables
LEPOTE [reading potentiometer
POSX [absolute position X
COMPX [temperature compensation X
VELX [Convert X axis
VEMA [spindle speed
RAM,8
NUMUT [numeric variable for ASC() instruction

INIT
PROG

GENERIC PROGRAM S3000

INP
IMAPR [Machine ready
OUT
ABX [enable X axis

[********DECLARE VARIABLES **************
[Substitute RAM with SRAM as the first is no longer retained in memory after switch off
SRAM,32 [variables
LEPOTE [reading potentiometer
POSX [absolute position X
COMPX [temperature compensation X
VELX [Convert X axis
VEMA [spindle speed
SRAM,8
NUMUT [numeric variable for MKN$() instruction
SRAM,1
[*the selection softkeys selecting the electronic hand wheel resolution were eliminated, but the PLC can choose one of the pre-defined steps in the configuration data with the use of the variable*
STEP
SOFTK
P01,L01, '.1 mm/ rev'
P02,L02, '.5 mm/rev'
P03,L03, ' 5 mm/rev'
P04,L04, ' 10 mm/rev'
P05,L05, 'reference axes'
INIT
PROG

[****** POTENTIOMETER MANAGEMENT **************

```
POTER =1                [potentiometer management
LEPOTE=LAD(POMA)        [reading pot. Input manual
                          [and format conversation
POMO=SDA(LEPOTE)        [writing value for NC format
                        [conversion
POFO=SDA(LEPOTE)
```

[****POTENTIOMETER MANAGEMENT ********

[The control is always by the PLC, the variable POTTER has been eliminated.
[It is necessary to eliminate the functions LAD() and SDA(): the variables relative to analog input/output are already in floating point.
[The variables POFE, POMA, POSP have been substituted with ANI(1), ANI(2), ANI(3).
[For manual mode a potentiometer for each axis is present

```
LEPOTE=ANI(1)
POMO(1)=LEPOTE
POMO(2)=LEPOTE
POMO(3)=LEPOTE
POFO=LEPOTE
```

[* AXES POSITION READING AND ORIGIN SHIFT*******

```
POSX=LRQ(POA(1))        [read  X axis
SHIFT(1)=SRQ(COMPX)     [compensate  X axis
```

[****AXES POSITION READING AND ORIGIN SHIFT *******

[It is necessary to eliminate the functions LRQ() and SRQ(): the variables relative to analog input/outut are already in floating point.

```
POSX= POA(1)            [read X axis
SHIFT(1)=COMPX          [compensate X axis
```

[** DECODING FUNCTIONS *****

```
[syntax of instruction COM, 1, 'LABEL'
IF(AUXM=6) COM, 1, 'L1'
RTS
```

[**DECODING FUNCTIONS *****

[Change the syntax of the instruction COM, 1, name program

```
IF(AUXM=6) COM, 1, 'CAMBUT'; RTS
```

[On SSA it is necessary to write axes configuration in M11

```
IF(AUXM=11) SSA=11111111B; RTS   [Axes always active
IF(AUXM=10) SSA=00000000B; RTS   [Axes locked
```

[**** ENABLE MANAGEMENT *******

```
ABX=MOVE(1)             [enable X
```

[****ENABLE MANAGEMENT *******

[Sostituire MOVE con MOVCN e fornire la cofiguraz. assi abilitati su [RDMOV

```
ABX=MOVCN(1)            [enable X
RDMOV=MOVCN             [axes enabled
```

[**** SPINDLE MANAGEMENT *******

[Entirely implemented by the PLC

[****SPINDLE MANAGEMENT *******

[Not changeable by simple substitutions, see relative paragraph.

[**** TOOL CHANGE MANAGEMENT *******

[Entirely implemented by the PLC

[****TOOL CHANGE MANAGEMENT *******

[Not changeable by simple substitutions, see relative paragraph.

[**** BREAK ACQUISITION *******

[On Break M30 is issued

```
IF(AUXM=30) CALL M30
```

[****BREAK ACQUISITION ********

[On Break M30 is not issued.
[The BRKA condition is set: then the break routine must be called

```
IF(AUXM=30) CALL M30    [ M30 call routine
IF(BRKA) CALL M30       [ BREAK call routine
```

[*** MACHINE READY MANAGEMENT *******

```
MAPR=IMAPR              [program and axes stop
```

[***MACHINE READY MANAGEMENT *******

[The MAPR has been split into two meanings

```
DHOLD="IMAPR            [data hold
FHOLD="IMAPR            [feed hold (axes)
```

[** MESSAGE DISPLAY *******

```
[DISPL, instruction syntax, line (variable)
DISPL,1(MSG1)           [display MSG1
[Conversion from number to string
MSG1= ASC(NUMUT)
```

[**MESSAGE DISPLAY *******

[Change the DISPL instruction syntax, line, variable

```
DISPL,1,MSG1            [display MSG
```

[substitute the function ASC() with MKN$()

```
MSG1= MKN$(NUMUT)
```

[** WRITE ANALOG OUTPUT **

```
OEDA(1)=1               [enable writing DAA X
DAA(1)=SDA(VELX)        [Convert axis X
DASP= SDA(VEMA)         [spindle speed
```

[**WRITE ANALOG OUTPUT **

[Eliminate OEDA() functions and format conversion

```
DAA(1)=VELX             [Convert axis X
DASP= VEMA              [spindle speed
```

[** MANUAL JOG ************ **
[In manual jog only

[** REFERENCING AXES **********
[Management not remote from NC
IF(NCMD=6) ...

[** SWITCH MANAGEMENT **********
[Management not remote from NC

END

[** MANUAL JOG **********
[To select the JOG movement in manual it is necessary to set the MOVMA register
MOVMA = JOGP ~ JOGM

[**REFERENCING AXES **********
[The state of RICERCA 0 (NCMD=6) no longer exists in the NC, alternativly it is necessary to enter the axis configuration (with or without home switch) then reference the axis using the variable MARK (no home switch) or MICZE (with home switch).
[For example it is possible to create a softkey with the PLC (P05,L05)
L05=FF(P05),((NCMD<>5)~(MIZEA=7)) [softk lamp
IF(L05) MICZE= 11111111B; ELSE MICZE=0 [with switch
or
IF(L05) MARK= 11111111B; ELSE MARK=0 [on marker

[**SWITCH MANAGEMENT **********
[The choice of steps must be managed by the PLC to be able to eventually utilize a remote console.
IF(P01) L01=1; L02=0; L03=0; L04=0
IF(P02) L02=1; L01=0; L03=0; L04=0
IF(P03) L03=1; L02=0; L01=0; L04=0
IF(P04) L04=1; L02=0; L03=0; L01=0
IF(L01) STEP=1 [selection of first step (predifined)
IF(L02) STEP=2 [selection of second step (predifined)
IF(L03) STEP=3 [selection of third step (predifined)
IF(L04) STEP=4 [selection of fourth step (predifined)

END

4. SUMMARY OF SIGNALS AND REGISTERS

4.1. SYMBOLS AND CONVENTIONS

The information found in this section concerns the previously defined variables that the NC (Numerical Control) exchanges with the PLC (Programmable Logic Controller).
For use as a handy reference during application development. For each subject area the tables state the following characteristics for each register variable or signal:

- The mnemonic name
- The format (in the **Dim** column)
  1 = bit
  8 = byte
  16 = word
  32 = floating point
  64 = double floating point
  STR = character string
- The synchronous constraints with the signal ***BURDY*** (in the **Sync** column)
- The information directions: from PLC to NC, vice versa or in both directions (in the **Direction** column).

Note: Writing to PLC read-only variables with the direction from the NC to the PLC and not vice versa, can have unpredictable consequences.

- A brief **Description** in the corresponding column.

The **units of measure** used are the following:

- for measurement of heights, distances, adjustment settings	mm
- for rotating dimensions	degrees
- for timing	msec, sec or min
- for speed:	mm/min
- for acceleration:	mm/(sec²)
- for spindle speed	revolutions/min
- for voltage	V

The **symbols** used are the following:

The character *()* after the name of a register indicates there is a multi-element vector in the specified format (for example, ***UTNUM()***, while ***MOVCN*** is a single register).

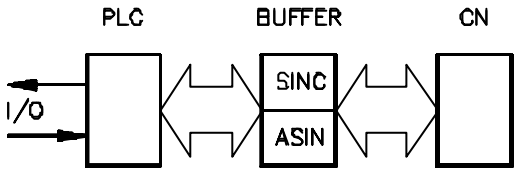
Whenever the symbol ***(1..n)*** appears following a listed item, the register or the vector must be interpreted by individually analyzing the elements from (1 to n). In order to determine a single register whose bits are described, it must be kept in mind that:

- The dimension of vector elements is greater than 1.
- When single register bits are described, these descriptions are generally preceded by the description of the register itself, which will be indicated without parentheses.

Example:

Name	Dim	Direction	Sync	Description
MOVCN	8	NC ⇨ PLC	no	Request axes enable (1..8).
MOVCN(1)	1	NC ⇨ PLC	no	(first bit of the byte) request for axis 1
MOVCN(8)	1	NC ⇨ PLC	no	(eighth bit of the byte) request for axis 8
UTNUM()	16	NC ⇔ PLC	no	Code of tool in table (1 ... ***UTENRI***), where ***UTENRI*** represents the number of lines in the tool table.
UTNUM(1)	16	NC ⇔ PLC	no	(first element of the word vector) the tool code present in line 1 of the tool table.
UTNUM(8)	16	NC ⇔ PLC	no	(eighth element of the word vector) the tool code present in line 8 of the tool table.

Note: For optimal legibility the above column headings are not reprinted above the tables shown throughout this text. please note that the information is consistently listed according to the column headings in the table above.



4.2. INTERCHANGE AND FLOW OF SIGNALS

NC Status

NCMD	8	NC ⇨ PLC	no	NC status code: 1 = position coordinates 2 = single block 3 = semi automatic program execution 4 = automatic program execution 5 = manual mode 8 = return to profile 9 = manual mode active during hold status
STBMD	1	NC ⇨ PLC	no	Strobe pulse signaling changes in NC status pulse duration is equal to one complete slow logic scan.
FNCMD	8	NC ⇦ PLC	no	NC forcing register in semi automatic program execution

Synchronous communication with the NC

BURDY	1	NC ⇔ PLC	yes	Signals the presence of new synchronous data for the machine logic. It is set by the NC and ***most important*** must be reset by the PLC as soon as the information is acquired.

Synchronous auxiliary and preparatory functions

AUXM	16	NC ⇨ PLC	yes	Last programmed M function (M0-M9999).
STROM	1	NC ⇨ PLC	yes	Strobe indicating presence of M function.
TOOL	16	NC ⇨ PLC	yes	Last programmed T function (T0-T32767).
STROT	1	NC ⇨ PLC	yes	Strobe indicating presence of T function.
AUXH	16	NC ⇨ PLC	yes	Last programmed H function (H0-H9999).
STROH	1	NC ⇨ PLC	yes	Strobe indicating presence of H function.
SPEED	32	NC ⇨ PLC	yes	Last programmed S function (S0-S99999).
STROS	1	NC ⇨ PLC	yes	Strobe indicating presence of S function.
STCOM	1	NC ⇨ PLC	yes	Strobe signaling the end of a COM subprogram.
FEED	64	NC ⇨ PLC	no	Last feed programmed.
AUXG	16	NC ⇨ PLC	no	Last programmed G function (G0-G9999).
CICFI	16	NC ⇨ PLC	no	Fixed cycle in progress.
AXPGM	8	NC ⇨ PLC	yes	Axes programmed in the block along with the auxiliary function (e.g. M11XYZ generates AXPGM=00000111B).
AUXVAL()	64	NC ⇨ PLC	yes	Array for transmitting the parameters I, J, K, Q along with the auxiliary functions M, H. ***AUXVAL(1)*** = parameter I ***AUXVAL(2)*** = parameter J ***AUXVAL(3)*** = parameter K ***AUXVAL(4)*** = parameter Q
STRAUX	8	NC ⇨ PLC	yes	Strobe for parameters I, J, K, Q. ***STRAUX(1)*** = strobe I ***STRAUX(2)*** = strobe J ***STRAUX(3)*** = strobe K ***STRAUX(4)*** = strobe Q
RCOM	1	NC ⇦ PLC		Activation of an asynchronous COM requested.
STRCOM	1	NC ⇨ PLC		Synchronization strobe for running of the COM requested with RCOM.
RCOM_	8	NC ⇦ PLC		Asynchronous COM activation requests for the single axis groups (1..8).

STRCO_	8	NC ⇨	PLC		Synchronization strobe for running of the COM requested with with **RCOM_** for the single axis groups (1..8).

Asynchronous Start, Stop, Alarm and Acknowledge controls

DHOLD	1	NC ⇦	PLC	no	Temporary stop of the program run beginning with the first subsequent block that contains a stop point in the continuous movement (typically an auxiliary function), without interruption of the activity in progress.
FHOLD	1	NC ⇦	PLC	no	Temporary stop of feed.
RHOLD	1	NC ⇦	PLC	no	External HOLD request. Temporary stop of programmed moves and blocks in execution.
HOLDA	1	NC ⇨	PLC	no	Axes in Hold state.
CYST	1	NC ⇦	PLC	no	External CYCLE START request.
SFKGRD	8	NC ⇨	PLC	no	Guard
SFKCNS	8	NC ⇨	PLC	no	Pulsing signals pushing CYCLE START (SFKCNS(1)), HOLD (SFKCNS(2)), BREAK (SFKCNS(3))
CYON	1	NC ⇨	PLC	no	Cycle in execution.
REME	1	NC ⇦	PLC	no	External EMERGENCY request.
EMEA	1	NC ⇨	PLC	no	NC in emergency alarm state or external emergency request.
RBRK	1	NC ⇔	PLC	no	External BREAK request. Interruption of the program or block in execution. Cancel emergency state.
BRKA	1	NC ⇨	PLC	no	Command to BREAK from PLC.

Part origins and Tool length compensation

OFST	16	NC ⇔	PLC	yes	Code of the length compensation to be activated.
INTOF	1	NC ⇔	PLC	yes	Strobe to signal the NC to activate the selected tool length compensation.
ORIG	16	NC ⇦	PLC	yes	Code of the part origin to be activated.
INORG	1	NC ⇔	PLC	yes	Strobe to signal the NC to activate the selected part origin.
BYORG	1	NC ⇦	PLC	yes	Temporary cancellation of origins and tool settings (absolute origin).
ABSOR	1	NC ⇨	PLC	no	Absolute origin active signal.
STORG_	8	NC ⇦	PLC		Register of the additional origin offset activation. **STORG_(1)** = 1 activates the offsets (for all the axes) **STORG_(1)** = 0 de-activates the offsets
PLORG()	8	NC ⇦	PLC		Registers containing the additional origin offsets

Enabling and disabling axes

MOVCN	8	NC ⇨	PLC	no	Axis enable request (1..8).
RDMOV	8	NC ⇦	PLC	no	Axis ready to move; response to MOVCN (1..8).
POFO	64	NC ⇦	PLC	no	Override value on the programmed feed (from 0 to 2 gives an adjustment between 0 and 200 per cent).

Axes always active or with locking

SSA	8	NC ⇦	PLC	no	Axes that must always be active (1..8).

Axes to be disabled

DSERV	8	NC ⇦	PLC	no	Axes to be disabled (1..8).

Disabling transducers

DISRQ	8	NC	⇦	PLC no	Axes with transducers disabled (1..8).

Manual JOG

MOVMA	8	NC	⇦	PLC no	Axes selected for manual movement (1..8).
JOGP	8	NC	⇦	PLC no	Command jog positive (1..8).
JOGM	8	NC	⇦	PLC no	Command jog negative (1..8).
POMO()	64	NC	⇦	PLC no	Velocity for manual movements and reference for each single axis (1..8) (from 0 to 1 as a percentage of the rapid velocity).

Manual movement with handwheel

HWL()	8	NC	⇦	PLC no	One per handwheel (1..3) to indicate the number of the axis to be controlled.
STEP	8	NC	⇦	PLC no	Selection of the handwheel resolution from the 8 values defined in the configuration parameters.

Homing the axes

MICZE	8	NC	⇦	PLC no	Axis selected for reference with home switch (1..8).
MARK	8	NC	⇦	PLC no	Axis selected for reference without home switch (1..8).
MIZER	8	NC	⇦	PLC no	Home switch for axis (1..8).
MIZEA	8	NC	⇨	PLC no	Axes referred to the electrical zero of transducer (1..8).

Manual movement and homing during program execution

FOMAN	8	NC	⇦	PLC yes	Axes on which to force manual control (1..8).

Axis information

For axis control

ERR()	64	NC	⇨	PLC no	Axis following error (1..8).
VATT	64	NC	⇨	PLC no	Actual velocity along the tool path.
TACH()	64	NC	⇨	PLC no	Axis velocity (1..8) .
VFF()	64	NC	⇨	PLC no	Instantaneous velocity axes (1..8).
AFF()	64	NC	⇨	PLC no	Instantaneous acceleration axes (1..8).
DAA()	64	NC	⇨	PLC no	Reference voltage for controlled axes (1..8). The DAA can only be read If the axis is active and under NC control. The content varies from -1 to 1 in relation to the input voltage of -10 and +10 V.
POA()	64	NC	⇨	PLC no	Absolute position of axes (1..8).
POO()	64	NC	⇨	PLC no	Axis position referred to the current origin and active tool compensation (1..8).
POATE()	64	NC	⇨	PLC no	Instantaneous calculated axis position along the trajectory of interpolation (1..8) relative to the absolute origin.
POOTE()	64	NC	⇨	PLC no	Instantaneous calculated axis position along the trajectory of interpolation (1..8) relative to the active origin.
POORT()	64	NC	⇨	PLC no	Instantaneous calculated position of any rotary translation of system coordinates along the trajectory of interpolation (1..8) relative to the active origin.
PFNC()	64	NC	⇨	PLC no	Final programmed axis position (1..8).
AXRIF()	64	NC	⇨	PLC	Speed command sent to the axes (1..8) [mm/min]

OFSVA()	64	NC ⇦ PLC	Additional speed offset for the axes (1..8) [mm/min]. (also impacts **AXRIF()** - use only for special applications)
AFF()	64	NC ⇨ PLC	Acceleration command imparted to the axes (1..8) [mm/sec^2]
OFHWL()	64	NC ⇨ PLC	Offsets (1..8) of the origin with G851 (in mm).
GDAVIS	8	NC ⇨ PLC	Number of the axis group that the display refers to.

Axis status

INTOL	8	NC ⇨ PLC	no	Axis (1..8) within “in position zone” defined in the parameters.
JOGIN	8	NC ⇨ PLC	no	Axis (1..8) moving following a JOG command (manual or referencing).
RAPI	1	NC ⇨ PLC	no	Blocks being executed in rapid.

Control of transducers and electronic handwheels

MKSAX	8	NC ⇨ PLC	no	Marker pulse signal (electrical zero) for encoders or optical scales for axes (1..8). Set by the NC when received from the transducer and reset by the subsequent system sampling; for this reason the pulse is only seen by using the graphic analyzer .
AIRGP()	64	NC ⇨ PLC	no	Signal level from analog transducers (INDUCTOSYN or RESOLVER); in the case of an ENCODER it is the number of lost pulses determined by the "recover step" function for the axes (1..8).
SPMANO()	64	NC ⇨ PLC	no	Distance per rev of the handwheel (1..3) according to the selected resolution. The distance accumulated is reset by changes of NC status and axis status (SSA, DSERV, ...)

Dynamic compensation of axis position

SHIFT()	64	NC ⇦ PLC	no	Dynamic compensation of axis position (1..8).

Offset for controlled axes

OFSDA()	64	NC ⇦ PLC	no	Offset applied to reference voltage on controlled axes (1..8) in the range ±1 for a reference voltage of ±10 Volt.

Contact probe management

CWDTF	8	NC ⇦ PLC	no	Control byte of contact probe (on/off): Bit 1: disables error 210 (collision)
SWDTF	8	NC ⇨ PLC		Status of the contact measurement probe ON/OFF. **SWDTF(2)** = 0 probe at rest = 1 probe deflected

Axis software limits

FICOP	8	NC ⇨ PLC	no	Axis (1..8) on positive software limit.
FICOM	8	NC ⇨ PLC	no	Axis (1..8) on negative software limit.
DFCOP	8	NC ⇦ PLC	no	Axis (1..8) disable positive software limit.
DFCOM	8	NC ⇦ PLC	no	Axis (1..8) disable negative software limit.
FCA()	8	NC ⇦ PLC	no	Secondary limits array activation

CWFCS	8	NC ⇦ PLC		Control of software limit errors. **CWFCS(1)** = 1 **E93** error report disabled **CWFCS (1)** = 0 **E93** error report enabled

Parallel axes (Gantry)

OFSGY	8	NC ⇦ PLC	no	Enable nominal offset gantry axis (1..8) .It must be set the bit corresponding to the SLAVE axis number

Programmable non-controlled axes

AUXPF()	64	NC ⇨ PLC	yes	Programmed positions for axes moved by the PLC (1..6).
STRPF	8	NC ⇨ PLC	yes	Strobe when new information is present on ***AUXPF***() (1..6).

Reading and writing analog inputs and outputs

ANIx()	64	NC ⇨ PLC	no	Analog input readings from the I/OMIX card specified and its expansions. The value read varies from 0 and 1 as a percentage of the full-range value..
VELOx()	64	NC ⇦ PLC	no	Analog output from the I/OMIX card specified and its expansions. These outputs can always be read, but written only if they are not utilized by the NC for the controlled axes or by the internal modules for management of the spindles or independent axes. The content can vary from -1 to 1 as a percentage of the full-range value (+/- 10 V).
TEMPx()	64	NC ⇨ PLC	no	Degrees of temperature read by the thermal probes (if the interface is present) associated with the specified card.

Data exchange between PLC and part program

LFL	32	NC ⇨ PLC	yes	FLOATING variable from part program to PLC.
STVFL	1	NC ⇨ PLC	yes	FLOATING variable strobe from part program to PLC.
VPLWO	16	NC ⇨ PLC	yes	WORD variable from part program to PLC.
STVWO	1	NC ⇨ PLC	yes	WORD variable strobe from part program to PLC.
VPLBY	8	NC ⇨ PLC	yes	BYTE variable from part program to PLC.
STVBY	1	NC ⇨ PLC	yes	BYTE variable strobe from part program to PLC.
VPLBI	1	NC ⇨ PLC	yes	BIT variable from part program to PLC.
STVBI	1	NC ⇨ PLC	yes	BIT variable strobe from part program to PLC.
VLPFL	32	NC ⇦ PLC	yes	FLOATING variable sent to the part program from the PLC.
VLPWO	16	NC ⇦ PLC	yes	WORD variable sent to the part program from the PLC.
VLPBY	8	NC ⇦ PLC	yes	BYTE variable sent to the part program from the PLC.
VLPBI	1	NC ⇦ PLC	yes	BIT variable sent to the part program from the PLC.
PNC()	32	NC ⇔ PLC	no	99 parameters in shared floating point format read and written to by both PLC and part program at the user level (1..99).
P()	32	NC ⇔ PLC	no	99 parameters in shared floating point format written to by the PLC or the subprogram COM instructions (1..99).

NC video display windows

WINDOW()	64	NC ⇦ PLC	no	Registers for NC video display areas (1..16) in the floating long or double point formats. The display of these areas is enabled by default values in the video tables.
ASCW()	8	NC ⇦ PLC	no	Registers for NC video character display in the preset areas (1..16). The ASCII character code must be used.

WNDINT()	16	NC ⇦ PLC	no	Registers for NC video character display in the preset areas(1..16) in word format.
WNDSTR()	str	NC ⇦ PLC	no	String registers containing a Max of 64 alphanumeric characters for the NC video display in the preset area (1..16).
GIRMI	64	NC ⇦ PLC	no	Register for the display of the S function value in the preset area of the NC video.
SFKMEN	8	NC ⇔ PLC	no	Current PLC softkey menu.
SFKLNG	16	NC ⇨ PLC	no	Active language code on NC
CNDVIS()	16	NC ⇦ PLC	no	Array to use for conditionings within video tables (1..64)
VISMC	16	NC ⇨ PLC		Number of the active video panel

System date and time

DATE(1)	16	NC ⇨ PLC	no	Year (last two digits)
DATE(2)	16	NC ⇨ PLC	no	Month
DATE(3)	16	NC ⇨ PLC	no	Day
DATE(4)	16	NC ⇨ PLC	no	Hour (0-24)
DATE(5)	16	NC ⇨ PLC	no	Minutes
DATE(6)	16	NC ⇨ PLC	no	Seconds

Copying and digitizing of surfaces

COPIA	8	NC ⇔ PLC	no	First byte for remote copying commands
COPIA(1)	1	NC ⇦ PLC	no	= 0 selects continuous digitization mode, data points are memorized as a function of the parameters of the manual copy program. = 1 selects the digitization mode, data points are memorized only following an pulse (transition from 0 to 1) on the bit COPIA(2) in manual copy.
COPIA(2)	1	NC ⇦ PLC	no	Digitizing signal see ***COPIA(1)***.
COPIA(3)	1	NC ⇔ PLC	no	Active copying cycle signal. When reset by PLC it signifies the end of the cycle. It is important to terminate a digitizing cycle by zeroing out this bit (or with the appropriate softkey if already implemented in the NC) otherwise the last points digitized will not be memorized.
COPIA(4)	1	NC ⇦ PLC	no	Signal to STEP (increment) +.
COPIA(5)	1	NC ⇦ PLC	no	Signal to STEP (increment) -.
COPIA(6)	1	NC ⇦ PLC	no	Signal to STEP (increment) and reverse copy direction.
COPIA(7)	1	NC ⇨ PLC	no	Active copy.
COPIA(8)	1			Not assigned
COPIA2	8	NC ⇔ PLC	no	Second byte for remote control of copy function.
COPIA2(1)	1	NC ⇦ PLC	no	passage in manual status.
COPIA2(2)	1	NC ⇦ PLC	no	0 = digitizing disabled. 1 = digitizing enabled.
COPIA2(3)	1	NC ⇦ PLC	no	Probe offset acquired.
COPIA2(4)	1	NC ⇦ PLC	no	1 = copying axis 1 locked. 0 = unlocked.
COPIA2(5)	1	NC ⇦ PLC	no	1 = copying axis 2 locked. 0 = unlocked

COPIA2(6)	1	NC ⇦ PLC	no	1 = copying axis 3 locked. 0 = unlocked
COPIA2(7)	1	NC ⇦ PLC	no	Reversal of copy direction.
COPIA2(8)	1	NC ⇦ PLC	no	0 = auto acquire surface disabled. 1 = auto acquire surface enabled.
COPIA3	8	NC ⇔ PLC	no	Third byte for remote copying commands.
COPIA3(1)	1	NC ⇦ PLC	no	Restart copying in the negative direction after loss of contact with the model axis 3.
COPIA3(2)	1	NC ⇦ PLC	no	Restart copying in the negative direction after loss of contact with the model axis 2.
COPIA3(3)	1	NC ⇦ PLC	no	Restart copying in the negative direction after loss of contact with the model axis 1.
COPIA3(4)	1	NC ⇦ PLC	no	Restart copying in the positive direction after loss of contact with the model axis 3.
COPIA3(5)	1	NC ⇦ PLC	no	Restart copying in the positive direction after loss of contact with the model axis 2.
COPIA3(6)	1	NC ⇦ PLC	no	Restart copying in the positive direction after loss of contact with the model axis 1.
COPIA3(7)	1	NC ⇦ PLC	no	Reserved.
COPIA3(8)	1	NC ⇦ PLC	no	Reserved.
COPIA4	8	NC ⇔ PLC	no	Fourth byte for remote control of copying functions.
COPIA4(1)	1	NC ⇦ PLC	no	Temporary stop after renewed contact with model.
COPIA4(2)				Reserved
COPIA4(3)				Reserved
COPIA4(4)				Reserved
COPIA4(5)				Reserved
COPIA4(6)				Reserved
COPIA4(7)				Reserved
COPIA4(8)				Reserved
PBSTS	8	NC ⇨ PLC	no	Register of digital probe status
POCOP	64	NC ⇦ PLC	no	Manual copying gain control. The value can vary from 0 to 1 and multiplies the gain of the control in copying from 1 to 5, varying the velocity of the axes with the deflection of the probe.
COPIA	8	NC ⇨ PLC		First byte for remote management of the copying commands **COPIA(8)** = 1 Signal that a copying cycle is being executed in Manual mode

Variables to verify system execution times

SMPTI	64	NC ⇨ PLC	no	Sample time (controlled axes) [msec]
OCCV	16	NC ⇨ PLC	no	Fast logic scan time (microseconds).
OCCI	16	NC ⇨ PLC	no	Time used in managing the controlled axes (microseconds).
OCCT	16	NC ⇨ PLC	no	Time used by the graphic analyzer (microseconds).
OCCP2P	16	NC ⇨ PLC	no	Time used in managing the independent axes (microseconds).
CCL	16	NC ⇨ PLC	no	Slow logic interrupt cycle counter.
CCUL	16	NC ⇨ PLC	no	Super slow logic interrupt cycle counter.

Error signals accessed by logic

ERSYS	16	NC ⇨ PLC no	System error code read on the controlled axes, spindles, independent axes, PLC runtime errors, errors in the automatic tool change module,
ERAXS	16	NC ⇨ PLC no	System error code read on the controlled axes (slave error, outside tolerance, transducer errors, etc.).
ERIOX	16	NC ⇨ PLC no	Error code read on the I/OMIX cards (encoder feedback failure, digital output error, etc.)
ERINT	16	NC ⇨ PLC no	Error code occurring during the interpolation calculations.
ERPLC	16	NC ⇨ PLC no	Runtime error code read during the execution of the PLC program (division by 0, overflow, underflow, etc.).
ERSPN	16	NC ⇨ PLC no	Error code read on the spindles (transducers, etc.)
ERP2P	16	NC ⇨ PLC no	Error code read on the independent axes (transducers, etc.)
ERCU	16	NC ⇨ PLC no	Error code read during tool change or incorrect tool tables, etc.
ER2LN	16	NC ⇨ PLC no	Error code caused by exceeding system sampling time.
ERCPY	16	NC ⇨ PLC no	Error code read during a copying cycle or touch probe sensor.
FPERMK	8	NC ⇔ PLC no	Disabling mask that senses errors on floating point calculations (division by zero, overflow).

Reading and modifying axis configuration parameters

AXSTP	8	NC ⇦ PLC no	Number of the axis whose parameters are to be modified.
VALSTP	64	NC ⇔ PLC no	Current value in the system configuration parameters.
	16	NC ⇦ PLC no	Configuration parameter code to access through the PLC (the parameters operate on a non static copy in memory); the new values are entered only when the axis final velocity = 0:

Code written	Parameter	Code read
-1	Rapid velocity	1
-2	Machining acceleration	2
-3	Rapid acceleration	3
-4	transducer axis backlash	4
-5	K_v gain	5
-6	Dynamic compensation	6
-7	Crossover recovery rate	7
-8	Crossover recovery time	8
-9	Maximum servo error	9
-10	Frict. comp. rate	10
-11	Acceleration error offset	11
-12	Negat. travel limit 1	12
-13	Posit. travel limit 1	13
-14	Transducer pitch	14
-15	Integral time constant	15
-16	Integral gain	16

ACTSTP	1	NC ⇔ PLC no	Start operation request signal on **HOWSTP**. Reset by NC when operation is finished.

INCH	1	NC ⇔ PLC	no	Kind of measure 0 = millimeters 1 = inches The NC sets this variable according to the related parameter stored in the system configuration area PLC can overwrite this variable to change the kind of measure but the new value will not be saved permanentlyin the system configuration parameter area

Various

_ENIDX	8	NC ⇦ PLC		activates/de-activates the diagnostic that checks validity of the indices for access to the individual variables and the vectors. **_ENIDX** = -1 diagnostic on **_ENIDX** = 0 diagnostic off (default)

4.3. DEDICATED MODULES

Spindle Rotation

SPVEL()	64	NC ⇦ PLC	no	Speed spindle(s)(1..4).
SPSSO()	64	NC ⇦ PLC	no	Override potentiometer spindle(s)(1..4).
SPDIR()	8	NC ⇦ PLC	no	Rotation direction spindle(s) (1..4).
SPROT	8	NC ⇦ PLC	no	Command spindle(s) (1..4).
SPREG	8	NC ⇨ PLC	no	Spindle(s) (1..4) up to speed.
SPMOT	8	NC ⇨ PLC	no	Spindle(s) (1..4) in motion.
SPRMP	8	NC ⇨ PLC	no	Spindle(s) (1..4) ramp up to speed.
SPSGL	8	NC ⇨ PLC	no	Effective speed within threshold spindle(s) (1..4).

Range change selection

SPGAM()	8	NC ⇦ PLC	no	Range selected (0 = neutral) spindle(s) (1..4).
SPPND	8	NC ⇦ PLC	no	Hunting command for range change spindle(s) (1..4).
SPSMG1()	64	NC ⇨ PLC	no	Maximum speed for range 1 spindle(s) (1..4).
SPSMG2()	64	NC ⇨ PLC	no	Maximum speed for range 2 spindle(s) (1..4).
SPSMG3()	64	NC ⇨ PLC	no	Maximum speed for range 3 spindle(s) (1..4).
SPSMG4()	64	NC ⇨ PLC	no	Maximum speed for range 2 spindle(s) (1..4).
SPSMAX()	64	NC ⇨ PLC	no	Maximum speed for spindle(s) (1..4).

Spindle orient

SPORI()	8	NC ⇦ PLC	no	Orient command spindle(s) (1..4).
SPTOL	8	NC ⇨ PLC	no	Oriented within tolerance spindle(s) (1..4).
SPPOS()	64	NC ⇦ PLC	no	Orient position spindle(s) (1..4).
SPVEOR()	64	NC ⇦ PLC	no	Speed reduction (from 0 to 1) during orientation spindle(s) (1..4).
SPOAB	8	NC ⇦ PLC	no	Orientation using absolute values spindle(s) (1..4).
SPORP	8	NC ⇦ PLC	no	Unidirectional positive orientation.
SPORM	8	NC ⇦ PLC	no	Unidirectional negative orientation.

Synchronization between spindles

SPSYN	8	NC ⇦ PLC	no	Synchronism command to slave spindle.
SPMAS()	8	NC ⇦ PLC	no	Master spindle numbers for synchronism with slave.
SPOFS()	64	NC ⇦ PLC	no	Offset between master spindle and slave.
SPRTO()	64	NC ⇦ PLC	no	Speed ratio for sync. between master spindle and slave(s).
SPAGG	8	NC ⇨ PLC	no	Slave spindle(s) (1..4) synchronized with master.

Common to all operations

SPMOV	8	NC ⇨ PLC	no	Request to move spindle(s) (1..4).
SPDIS	8	NC ⇦ PLC	no	General disable command spindle(s) (1..4).
SPDRQ	8	NC ⇦ PLC	no	Disable transducer spindle(s) (1..4).
SPTCH()	64	NC ⇨ PLC	no	Effective speed spindle(s) (1..4).
PASP()	64	NC ⇨ PLC	no	Angular position from transducer(s) (1..4).
SPMZA	8	NC ⇔ PLC	no	Transducer(s) referenced to electrical zero. Can be reset to repeat the zero search.
SPMKS	8	NC ⇨ PLC	no	Encoder(s) marker pulse spindle(s) (1..4).
SPAGP()	8	NC ⇨ PLC		Transducer level or pulses lost and recovered for the spindles (1..4).
SPRIF()	64	NC ⇨ PLC		Speed command sent to the spindles (1..4) [revs/min] can be used to check the acceleration/deceleration ramps by comparing **SPRIF** with **SPTCH** (actual speed) for spindles with transducer.

Fixed cycle G84

SPGDA	8	NC ⇦ PLC	no	Spindle to used for fixed cycle G84 with transducer.

Independent axis movement module

MOVP2P	8	NC ⇨ PLC	no	Request to enable movement axes (1..8).
RDMP2P	8	NC ⇦ PLC	no	Movement enabled axes (1..8); response to ***MOVP2P***.
SSAP2P	8	NC ⇦ PLC	no	Axes that must be enabled at all times (1..8).
DSVP2P	8	NC ⇦ PLC	no	Axes to be freed (1..8).
DRQP2P	8	NC ⇦ PLC	no	Command to disable the transducers on axes (1..8).
MVMP2P	8	NC ⇦ PLC	no	Axes that may be selected in manual mode (1..8).
MRKP2P	8	NC ⇦ PLC	no	Axes selected to be homed without reference switch (1..8).
MCZP2P	8	NC ⇦ PLC	no	Axes selected to be homed with reference switch (1..8).
MIZP2P	8	NC ⇦ PLC	no	Reference microswitch for axes (1..8).
MZAP2P	8	NC ⇨ PLC	no	Axes referred to transducer zero then repositioned after homing (1..8).
POTP2P()	64	NC ⇦ PLC	no	Speed regulation potentiometer for axes (1..8). From 0 to 100 percent of the speed if in automatic, or of the acceleration, if in manual.
JGPP2P	8	NC ⇦ PLC	no	Command JOG positive axes (1..8).
JGMP2P	8	NC ⇦ PLC	no	Command JOG negative axes (1..8).
PFNP2P()	64	NC ⇦ PLC	no	Automatically move to programmed position axes (1..8).
RUNP2P	8	NC ⇦ PLC	no	Positioning commands in automatic for axes, (1-8). They must be set by the PLC to command the movement to the set position; they are reset by the NC when the axis, having ended the movement, enters the in position threshold set in configuration data.

RHDP2P	8	NC ⇦ PLC	no	HOLD request, axes (1..8). Temporary hold of movement; the operation continues without further commands as soon as axes are released.
HDAP2P	8	NC ⇨ PLC	no	HOLD request, axes (1..8). Temporary hold of movement; the operation continues without further commands as soon as axes are released.
RBKP2P	8	NC ⇔ PLC	no	BREAK request on movements in automatic, axes (1..8). **RBKP2P** is reset by the NC when acquired. The axes are decelerated to a stop, and the **RUNP2P** is reset. In emergency state (**EMAP2P**) it is used to cancel the emergency but only if the request has been removed (**REMP2P**).
BKAP2P	8	NC ⇔ PLC	no	Axes not in motion following a **RBKP2P** command (1..8); they can be reset by the PLC, but this is not binding.
REMP2P	8	NC ⇨ PLC	no	Request to go to an emergency state axes (1..8).
EMAP2P	8	NC ⇨ PLC	no	Axes in emergency state. Going in to this state, the axes are disabled immediately without a controlled deceleration (1..8).
POAP2P()	64	NC ⇨ PLC	no	Absolute position read from transducer axes (1..8).
TCHP2P()	64	NC ⇨ PLC	no	Effective speed (from transducer) axes (1..8).
SGLP2P	8	NC ⇨ PLC	no	Axes within positioning tolerance set in the configuration (1..8).
MKSP2P	8	NC ⇨ PLC	no	Marker pulse (electrical zero) for axes (1.8) with encoder or optical scales.
FCPP2P	8	NC ⇨ PLC	no	Axes(1..8) where actual value results are greater than the positive travel limit set in the configuration.
FCMP2P	8	NC ⇨ PLC	no	Axes(1..8) where actual value results are greater than the negative travel limit set in the configuration.
VATP2P()	64	NC ⇨ PLC	no	Theoretical speed (computed) axes (1..8). If in the configuration data it is declared that the D/A converter is not present the reference in voltage will not be sent through the output channel, but the speed in this register is always available.
JINP2P	8	NC ⇨ PLC	no	Axes (1..8) in motion after a ***JOGP2P*** command.
DIRP2P	8	NC ⇨ PLC	no	Axes (1..8) motion direction (revealed by the analog reference sign). The value 1 means negative speed.
FEDP2P()	64	NC ⇔ PLC	no	Feed speed, axes (1..8).
RAPP2P()	64	NC ⇔ PLC	no	Rapid speed, axes (1..8).
VLNP2P()	64	NC ⇔ PLC	no	Slow zone speed, axes (1..8).
ZLNP2P()	64	NC ⇔ PLC	no	Slow zone distance, axes (1..8).
DEXP2P()	64	NC ⇔ PLC	no	Exponential deceleration distance, axes (1..8).
ACMP2P()	64	NC ⇔ PLC	no	Acceleration in manual, axes (1..8).
ACCP2P()	64	NC ⇔ PLC	no	Acceleration in automatic, axes (1..8).
DECP2P()	64	NC ⇔ PLC	no	Deceleration from feed speed to slow speed, axes (1..8).
DE2P2P()	64	NC ⇔ PLC	no	Exponential deceleration from slow speed, axes (1..8).
TOLP2P()	64	NC ⇔ PLC	no	Positioning tolerance, axes (1..8).
OFSP2P()	64	NC ⇔ PLC	no	Transducer offset applied to the reading to obtain the absolute value ***POAP2P()*** (1..8).
SHIP2P()	64	NC ⇦ PLC		Origin shift for independent axes (1..8). Allows definition of a zero position different from the absolute zero. The final positions of **PFNP2P()** are always referred to **POOP2P()**.
POOP2P()	64	NC ⇦ PLC		Independent axis position (1..8) affected by the origin shift **SHIP2P()**.

Tool change management module

UTECU	16	NC ⇦	PLC	no	Tool number request to tool change module**.** **UTECU = 0** is a particular code reserved for the return tool sequence from spindle to crib (or on the floor if no space is available)**.**
NEWCU	1	NC ⇔	PLC	no	New Sequence activation command for TC. This signal is set by the PLC to activate the tool exchange module and it is reset by the TC as soon as it is acquired**.**
NSEQCU	16	NC ⇨	PLC	no	Last TC code sequence undertaken.
BRDYCU	1	NC ⇔	PLC	no	Strobe of new code presence on **OPERC**U. It is set by TC and must be reset by the PLC as soon as the new operation has been acquired.
MAPRCU	1	NC ⇨	PLC	no	Machine ready for tool change: if equal to 0, the sequence will be suspended until released.
OPERCU	16	NC ⇨	PLC	no	Operation code requested by the TC from the PLC.
PPRECU	16	NC ⇨	PLC	no	New tool pick-up reaching position.
PPOSCU	16	NC ⇨	PLC	no	Old tool return reaching position.
CUATT	1	NC ⇔	PLC	no	TC generated signal when a new sequence initiates, reset by the PLC when the current sequence is considered terminated.
M6PGM	1	NC ⇔	PLC	yes	(M6 programmed) must be synchronized with the BURDY by the PLC, it is reset by the TC when, the M06 wait operation is received and the NC sub-program (COM) has been run. In absence of this signal, the sequence stops on the phase (-6). An active **M6PG**M implicates an automatic suspension of the execution of NC blocks !
UTSPCU	16	NC ⇔	PLC	no	Number of tool in spindle (read only).
UTSICU	16	NC ⇔	PLC	no	Number of tool in intermediate station (read only).
UTPICU	16	NC ⇔	PLC	no	Number of tool in jaws (read only).
EMACU	1	NC ⇨	PLC	no	Tool change in emergency state. This is set when the TC sequence is interrupted by a TC emergency request. The presence of this signal means that the tool information present in the table can not be justified with respect to the real situation. Operator intervention is necessary, any requests for new tool changes, **NEWCU,** are ignored..
REMCU	1	NC ⇦	PLC	no	TC emergency request. This command interrupts the TC current sequence and the running operation, putting the TC in an emergency state.
RBKCU	1	NC ⇔	PLC	no	Exit from the **EMACU** TC emergency state and a tool change sequence interruption request.
SELECU	8	NC ⇦	PLC	no	Form selector. It must be arranged before the tool change module is activated it is acquired at the beginning of the sequence and can not be modified during the same. 0 = TC mode normal 1 = TC mode with crib excluded 2 = TC mode with storage programmed tool load 3 = TC mode with programmed tool lay down
ERCU	16	NC ⇨	PLC	no	Error code displayed by the TC. At every operation the information relative to storage, tool table and configuration is verified. In case the information is not valid or in situations not foreseen or not manageable the TC interrupts the active sequence and communicates the error. In addition no TC sequence is operable if it is an error condition.

Tool tables

UTENRI	16	NC ⇨ PLC	no	Line number in the tool, maximum number of vector elements representing the columns in the tool table.
UTNUM()	16	NC ⇔ PLC	no	Tool codes in the table (1 .. ***UTENRI***).
UTPOS()	16	NC ⇔ PLC	no	Tool storage location (1 .. ***UTENRI***).
UTCAP()	16	NC ⇔ PLC	no	Tool "fathers" (1 .. ***UTENRI***).
UTDIM()	8	NC ⇔ PLC	no	Tool types (1 .. ***UTENRI***) where: 0 = small 1 = medium 2 = large 3 = extra
UTSPC()	8	NC ⇔ PLC	no	Special tools (1 .. ***UTENRI***) where: 0 = normal tool not 0 = special tool
UTPLKO()	8	NC ⇔ PLC	no	Excluded tools (1 .. ***UTENRI***) where: 0 = tools not excluded not 0 = tool excluded
UTVTKO()	8	NC ⇔ PLC	no	Life expired (1 .. ***UTENRI***) where: 0 = life not expired not 0 = life expired
UTVITA()	64	NC ⇔ PLC	no	MAX tool life (1 .. ***UTENRI***) in 1/100 of a second.
UTVTRE()	64	NC ⇔ PLC	no	Remaining tool life (1 .. ***UTENRI***) in 1/100 of a second.
UTVTMI()	64	NC ⇔ PLC	no	Minimum tool life (1 .. ***UTENRI***) in 1/100 of a second.
UTWD1()	16	NC ⇔ PLC	no	***WORD#1*** - variable 1 for application (1..***UTENRI***).
UTWD2()	16	NC ⇔ PLC	no	***WORD#2*** - variable 2 for application (1..***UTENRI***).
UTFP1()	32	NC ⇔ PLC	no	***FLOAT#1*** - variable 1 (floating point) for application (1 .. ***UTENRI***).
UTFP2()	32	NC ⇔ PLC	no	***FLOAT#2*** - variable 2 (floating point) for application (1 .. ***UTENRI***).
UTEFRE	16	NC ⇨ PLC	no	Number of entries still available in temporary memory for updating tool tables.
MAGNPO	16	NC ⇨ PLC	no	Number of tool storage locations configured in the parameters.
MAGCUA()	16	NC ⇨ PLC	no	Array representing tool storage image (0 .. ***MAGNPO***).
UTRUN	1	NC ⇦ PLC		Tool in spindle in machining phase: decrement RESIDUAL LIFE
UTTIM	32	NC ⇨ PLC		Value of the RESIDUAL LIFE counter of the tool in the spindle.
UTSTS	8	NC ⇨ PLC		Status register of tool in the spindle: UTSTS (1) = life finished UTSTS (2) = remaining life <= 0
CUATYP	16	NC ⇨ PLC		Type of tool change selected 0 = manual 1 = manual S1200 2 = automatic
MAGGEO	16	NC ⇨ PLC		Selected storage geometry 0 = chain 1 = planar
MAGTYP	16	NC ⇨ PLC		Selected disposition of tools in storage 0 = fixed 1 = random 2 = fixed random
MAGGST	16	NC ⇨ PLC		Selected storage management 0 = synchronous 1 = asynchronous 2 = semiasynchronous

5. LIMITS

The data shown summarizes the compiler limits to be used as a reference during program writing:

Max length of program instructions (logic line)	500 characters
Max length program line (physical line)	62 characters (+8 numbers)
Max number of lines linked together with $	24 physical lines
Max memory area for retentive variable about	3 Kbytes
Max memory area for non retentive variables about	50 Kbytes
Max number of fast timers	32
Max number of slow timers	64
Max number of counters	48
Max number of pulses	64
Max number of nested EXECs	4
Max number of multiplexer	16
Max number of GOTC branches	255
Max number of GOTP branches	16
Max length for microeditor softkey lines	20

Max positive number representable in byte format	127
Max negative number representable in byte format	-128
Max positive number representable in word format	32767
Max negative number representable in word format	-32768
Max number representable in long format	3.4 x 1038
Min number representable in long format	1.2 x 10-38
Max number representable in double format	1.8 x 10307
Min number representable in double format	2.2 x 10-308

PART III

PROGRAMMING EXAMPLES

1. PLC PROGRAMMING EXAMPLES

The following pages list several real-world examples of PLC programming, which can be used as a starting point to develop new applications.

The examples are self-documented and additional explanations should not be necessary. Of course, to interpret the examples, you must have a knowledge of PLC programming or, at least, must have thoroughly read the first two sections of this manual.

The examples are broken into modules, each carrying out a specific function described in the title of the program itself. The title also includes the name of the file, which is available from Selca upon request.

BAS300F - Basic machine (3 axes and spindle)

```
N1  [*****************************************************
N2  [*        BASIC MACHINE  3 AXES AND SPINDLE S3045
N3  [*        ***********************************************
N4  [*        BAS300F   941008
N5  [*****************************************************
N6  [Note: Maximum length of line is 62 char. + 8 numbers
N7  [
N8  [***************** DECLARATION SECTION *****************
N9  [
N10 [         physical inputs
N11 INP
N12 IMAPR              [ 1 machine ready
N13 IHOLD              [ 2 external hold
N14 ISTART    [ 3 external start
N15 IMZX               [ 4 X axis zero micro switch\
N16 IMZY               [ 5 Y axis zero micro switch > only for non absolute
N17 IMZZ               [ 6 Z axis zero micro switch/
N18 TERM,23   [ jump to input  23
N19 IREME              [24 external emergency
N20 [
N21 [         physical output
N22 OUT
N23 UMOVE1    [ 1 enable axis 1
N24 UMOVE2    [ 2 enable axis 2
N25 UMOVE3    [ 3 enable axis 3
N26 TERM,4
N27 UMAN               [ 5 enable spindle
N28 UREF               [ 6 coolant
N29 ALARM              [ 7 CNC in emergency
N30 LAHOLD    [ 8 axis hold lamp
N31 LACYON    [ 9 cycle start lamp
N32 [
N33 [         internal variables
N34 RAM,1
N35 ROTMA              [spindle status in memory
N36 CICL               [machine reference cycle
N37 [
N38 [         message string
N39 STR
N40 MSG1
N41 [
N42 [         softk menu managed by  PLC
N43 SOFTK,1
N44 P1,L1,1,'JOG  AXIS X+'
N45 P2,L2,1,'JOG  AXIS X-'
N46 P3,L3,1,'JOG  AXIS Y+'
N47 P4,L4,1,'JOG  AXIS Y-'
N48 P5,L5,1,'JOG  AXIS Z+'
N49 P6,L6,1,'JOG  AXIS Z-'
N50 P7,L7,'REFERENCE AXES'
N51 P8,L8,'HANDWHEEL',2
N52 [
N53 SOFTK,2
N54 P21,L21,'X AXIS HANDWHEEL '
N55 P22,L22,'Y AXIS HANDWHEEL '
N56 P23,L23,'Z AXIS HANDWHEEL '
N57 P24,L24,' 0.5 mm   /rev'
N58 P25,L25,'  1  mm   /rev'
N59 P26,L26,'  5  mm   /rev'
N60 P27,L27,' 10  mm   /rev'
N61 P28,L28,'  JOG MODE',1
N62 [
N63 [***************** INITIALIZATION  SECTION ***************
N64 INIT
N65 [test of KMW(1): is machine ref required?
N66 IF(KMW(1)=1) CICL=1; ELSE CICL=0
N67 SPGAM(1)=1                                  [spindle range 1.
N68                                             [message init
N69 MSG1='Reference machine axes'         [reference machine message
N70 L24=1                                       [default handwheel resolution
N71 SSA=00000111B                         [ XYZ axes unlocked
N72 [
N73 PROG
N74 [***************** FAST SECTION ************************
N75 END
N76 [***************** SLOW SECTION ************************
```

```
N77 [ ....SYNCHRONIZED  with part program.......
N78 [ .......... auxilliary function decode ..........
N79 IF("BURDY)ASYNC
N80 DHOLD=1; FHOLD=1
N81 IF(STROM) CALL GEFUM
N82 BURDY=0
N83 ASINC:$
N84 [
N85 [.....ASYNCHRONOUS PART.........
N86 [ ................ potentiometers ...................
N87 POFO=ANI(1)                          [automatic feed
N88 POMO(1)=ANI(2)              [manual feed
N89 POMO(2)=ANI(2)
N90 POMO(3)=ANI(2)
N91 [
N92 [..................spindle............................
N93 SPSSO(1)=ANI(3)             [spindle override
N94 SPVEL(1)=SPEED              [spindle speed
N95 SPROT(1)=ROTMA&"HOLDA       [comand start and HOLD
N96 UMAN=SPMOV(1)               [enable spindle
N97 [
N98 [..................... axis management.....................
N99 UMOVE1=MOVCN(1)             [enable move X
N100         UMOVE2=MOVCN(2)             [enable move Y
N101         UMOVE3=MOVCN(3)             [enable move Z
N102         RDMOV=MOVCN                 [OK to move from NC
N103         [
N104         [.......................jog.......................
N105         [NOTE  do not inhibit jog with  NCMD=8 and NCMD=9
N106         [as it is necessary to to use manual to reposition on the part
N107         [during HOLD state.
N108         [softkey managment:         in manual JOG+ and JOG-
N109         [                           machine homing only JOG+
N110         L1=P1
N111         L2=P2&"L7
N112         L3=P3
N113         L4=P4&"L7
N114         L5=P5
N115         L6=P6&"L7
N116         [
N117         JOGP(1)=L1                  [assigning JOG
N118         JOGM(1)=L2
N119         JOGP(2)=L3
N120         JOGM(2)=L4
N121         JOGP(3)=L5
N122         JOGM(3)=L6
N123         MOVMA=JOGP~JOGM             [select manual JOG mode
N124         [
N125         [ .................handwheels ......................
N126         [softkey to select axis to be moved with the handwheel
N127         IF(P21) L21="L21;L22=0;L23=0
N128         IF(P22) L22="L22;L23=0;L21=0
N129         IF(P23) L23="L23;L21=0;L22=0
N130         IF(L21) HWL(1)=1;L8=1
N131         IF(L22) HWL(1)=2;L8=1
N132         IF(L23) HWL(1)=3;L8=1
N133         IF("L21&"L22&"L23) HWL(1)=0;L8=0
N134         [softkey for assigning steps
N135         IF(P24) L24=1;L25=0;L26=0;L27=0
N136         IF(P25) L24=0;L25=1;L26=0;L27=0
N137         IF(P26) L24=0;L25=0;L26=1;L27=0
N138         IF(P27) L24=0;L25=0;L26=0;L27=1
N139         IF(L24) STEP=1
N140         IF(L25) STEP=2
N141         IF(L26) STEP=3
N142         IF(L27) STEP=4
N143         [
N144         [..............machine homing.....................
N145         IF(P7) L7="L7                          [enable homing softkey
N146         IF((SFKMEN<>1)~(NCMD<>5)~IREME~BRKA) L7=0
N147         [reference machine if micro switch present
N148         MICZE(1)=L7
N149         MICZE(2)=L7
N150         MICZE(3)=L7
N151         MIZER(1)=IMZX
N152         MIZER(2)=IMZY
N153         MIZER(3)=IMZZ
N154         [
N155         [...................general............................
```

```
N156         FHOLD="IMAPR ~ SPRMP(1)&"RAPI ~ $
N157         (((NCMD<>5)&(MIZEA<>7))&CICL) [stop axes movement
N158         DHOLD="IMAPR                          [data  hold machine not ready
N159         RHOLD=IHOLD                           [external hold request
N60 REME=IREME                                     [external emergency
N161         CYST=ISTART                           [external start request
N162         [
N163         ALARM=EMEA                            [NC in emergency state
N164         [
N165         IF(BRKA~EMEA) CALL RESET     [PLC functions reset from NC
N166         [
N167         END
N168         [********************** VERY SLOW SECTION ****************
N169         [............ display  message  and lamps ..............
N170         IF((MIZEA<>7)&CICL) DISPL,0,MSG1; ELSE CLR,0 [m/c ref message
N171         [
N172         LAHOLD=HOLDA                          [hold lamp
N173         LACYON=CYON                           [program runing lamp
N174         [
N175         WNDINT(2)=AUXH                        [H code display
N176         GIRMI=INT(ABS(SPTCH(1)))              [effective speed display
N177         END
N178         [
N179         [********************** ROUTINES SECTION******************
N180         [
N181         [ ........ decode M  function.........................
N182         GEFUM:$
N183         WNDINT(1)=AUXM                                  [display M codes
N184         IF (AUXM=3) ROTMA=1; SPDIR(1)=0; RTS  [spindle CW
N185         IF (AUXM=4) ROTMA=1; SPDIR(1)=1; RTS  [spindle CCW
N186         IF (AUXM=5) ROTMA=0; RTS                        [stop spindle
N187         IF (AUXM=7) UREF=1; RTS                         [coolant on
N188         IF (AUXM=9) UREF=0; RTS                         [axes clamped
N190         IF (AUXM=11) SSA=00000111B; RTS                 [axes unclamped
N191         IF (AUXM=13) ROTMA=1; SPDIR(1)=0; UREF=1; RTS   [man.+ ref.
N192         IF (AUXM=14) ROTMA=1; SPDIR(1)=1; UREF=1; RTS   [man.+ ref.
N193         IF (AUXM=30) CALL RESET; RTS                    [reset NC + PLC
N194         RTS
N195         [
N196         [............ reset  routine.............................
N197         RESET:$
N198         ROTMA=0            [stop spindle
N199         UREF=0             [coolant off
N200         SFKMEN=1           [return to main menu
N201         WNDINT(1)=30       [display M30
N202         RTS
N203         [........... end of program ..............................
```

COMI3045 - 3 axis machine, slide clamps, spindle orient

```
N1    [*******************************************************
N2    [*    3 AXIS MACHINE WITH CLAMPING
N3    [*    SPINDLE ORIENT 2 SPEED RANGES
N4    [*    MACHINE REFERENCING (Z THEN XY)
N5    [*    LOGIC FOR  AUXILIARY LIGHTS
N6    [*    LUBRICATION DEPENDANT ON AXIS MOVMENT
N7    [*          ****************
N8    [*          3045: 941008
N9    [*******************************************************
N10   [
N11   [
N12   [*************** DECLARATION SECTION ********************
N13   [
N14   [     physical inputs
N15   [
N16   INP
N17   IMUON       [1  machine on
N18   ISTART            [2  external start
N19   IHOLD       [3  external hold
N20   IMG1              [4  gear range 1 microswitch
N21   IMG2              [5  gear range 2 microswitch
N22   IMAMAO            [6  manual spindle CW
N23   IMAMAA            [7  manual spindle CCW
N24   ISTOPM            [8  manual spindle stop
N25   IGIROK            [9  spindle upto speed
N26   IDRAOK            [10 axis drives OK
N27   IDRMOK            [11 spindle drive OK
N28   ILIVOL            [12 oil level
N29   ILIVRE            [13 coolant level
N30   ITERMI            [14 temp. OK
N31   IOLTRC            [15 auxiliary axes OK
N32   IFICUT            [16 End of Tool change signal
N33   IMZX        [17 X axis home switch\
N34   IMZY        [18 Y axis home switch > only for non-absolute
N35   IMZZ        [19 Z axis home switch/
N36   [
N37   [     physical output
N38   OUT
N39   UMOVE1            [1  enable axis 1
N40   UMOVE2            [2  enable axis 2
N41   UMOVE3            [3  enable axis 3
N42   TERM,4            [   jump to output 5
N43   UMAN              [5  enable spindle
N44   USFREX            [6  unclamp X axis
N45   USFREY            [7  unclamp Y axis
N46   USFREZ            [8  unclamp Z axis
N47   UREF              [9  coolant on
N48   CNOK              [10 NC ok for auxiliary
N49   LAHOLD            [11 hold lamp
N50   LACYON            [12 cycle on lamp
N51   OKVG1       [13 range 1 command
N52   OKVG2       [14 range 2 command
N53   UKLUBA            [15 axis lube
N54   ULAM06            [16 M06 lamp
N55   [
N56   [     internal variables
N57   RAM,8
N58   MOVCNP            [copy of old MOVCN for derivative
N59   NM                [message number
N60   NR                [number of lines  per message
N61   NMAX              [maximum number of messages
N62   SG                [message flag bytes  1 - 8
N63   SG2               [message flag bytes   9 -16
N64   SG3               [message flag bytes  17 -24
N65   SG4               [message flag bytes 25 -32
N66   [
N67   RAM,1
N68   RIC0X       [homing X axis
N69   RIC0Y       [homing Y axis
N70   RIC0Z       [homing Z axis
N71   ZERIOK            [Axes homed
N72   SJOG              [JOG status enable
N73   RORMA       [M3 in memory
N74   RANMA       [M4 in memory
N75   RM41              [force range 1
```

```
N76   RM42             [force range 2
N77   GAM1             [range 1 request in memory
N78   GAM2             [range 2 request in memory
N79   CAUT             [tool change active
N80   G84              [tapping cycle active
N81   [
N82   STR
N83   MSG(32)          [table 32 messages
N84   [
N85   STIMER
N86   TIM06,TUM06,TDM06,TAM06,TWM06           [flash TC lamp
N87   TIM19,TUM19,TDM19,TAM19,TWM19           [spindle M19
N88   TIMUON,TUMUON,TDMUON,TAMUON,TWMUON [aux on
N89   TISBX,TUSBX,TDSBX,TASBX,TWSBX           [unlock X axis
N90   TISBY,TUSBY,TDSBY,TASBY,TWSBY           [unlock Y axis
N91   TISBZ,TUSBZ,TDSBZ,TASBZ,TWSBZ           [unlock Z axis
N92   TIBLX,TUBLX,TDBLX,TABLX,TWBLX           [lock X axis
N93   TIBLY,TUBLY,TDBLY,TABLY,TWBLY           [lock Y axis
N94   TIBLZ,TUBLZ,TDBLZ,TABLZ,TWBLZ           [lock Z axis
N95   TLUBI,TLUBU,TLUBD,TLUBA,TLUBW           [axes lube
N96   [
N97         SOFTK,1
N98         P1,L1,1,'JOG  AXIS     X+'
N99         P2,L2,1,'JOG  AXIS     X-'
N100  P3,L3,1,'JOG  AXIS     Y+'
N101  P4,L4,1,'JOG  AXIS     Y-'
N102  P5,L5,1,'JOG  AXIS     Z+'
N103  P6,L6,1,'JOG  AXIS     Z-'
N104  P7,L7,' REFERENCE AXES'
N105  P8,L8,'HANDWHEELS',2
N106  SOFTK,2
N107  P21,L21,'HANDWHEEL X '
N108  P22,L22,'HANDWHEEL Y '
N109  P23,L23,'HANDWHEEL Z '
N110  P24,L24,' 0.4 mm  per rev'
N111  P25,L25,'  1  mm  per rev'
N112  P26,L26,'  5  mm  per rev'
N113  P27,L27,''
N114  P28,L28,'JOG AXES',1
N115  [
N116  INIT
N117  [***************** INITIALIZATION SECTION ***************
N118  L24=1 [default handwheel resolution
N119  [
N120  NMAX=32    [define max number of messages
N121  MSG(1)= 'AUXILIARY DISCONNECTED'
N122  MSG(2)= 'HOME THE AXES'
N123  MSG(3)= '- to start automatic cycle first JOG Z+'
N124  MSG(4)= 'SPINDLE NOT READY'
N125  MSG(5)= 'GEAR CHANGE ACTIVE'
N126  MSG(6)= 'AXES FUNCTION FAULT'
N127  MSG(7)= 'SPINDLE FUNCTION FAULT'
N128  MSG(8)= 'LOW OIL LEVEL'
N129  MSG(9)= 'LOW COOLANT LEVEL'
N130  MSG(10)='TERMICI SCATTATI'
N131  MSG(11)='AXES IN OTHER FUNCTION'
N132  MSG(12)='MANUAL TOOL CHANGE'
N133  MSG(13)='WAIT FOR CLAMPING / UNCLAMPING AXES'
N134  [...
N135  MSG(32)='MESSAGE32'
N136  [
N137  PROG
N138  [***************** FAST SECTION ************************
N139  END
N140  [***************** SLOW SECTION ***************************
N141  [SYNCHRONOUS PART————————————————————
N142  [
N143  IF("BURDY)ASINC
N144  DHOLD=1; FHOLD=1
N145  IF(STROT)CALL GEFUT
N146  IF(STROM)CALL GEFUM
N147  BURDY=0
N148  ASINC: $
N149  [
N150  [..............ASYNCHRONOUS PART.........................
N151  [........... axes potentiometer managment..................
N152  POFO=ANI(1)      [automatic
N153  POMO(1)=ANI(2)         [manual X
N154  POMO(2)=ANI(2)         [manual Y
```

```
N155  POMO(3)=ANI(2)         [manual Z
N156  [
N157  [.......... manual spindle control .................
N158  IF (NCMD<>5) SPAUTO
N159  IF (IMAMAO) CALL M03
N160  IF (IMAMAA) CALL M04
N161  IF (ISTOPM) CALL M05
N162  SPAUTO:$
N163  [
N164  G84=(CICFI=84)   [fixed cycle G84 active
N165        [spindle speed override
N166        [Automatic  70% - 130%
N167        [Tapping  100%
N168        [Manual 0% - 100%
N169  IF (NCMD=5) SPVEL(1)=SPSMAX; SPSSO(1)=ANI(3); NOVEMA
N170  SPVEL(1)=SPEED
N171  IF(G84) SPSSO(1)=1; $
N172  ELSE SPSSO(1)=0.7 + ANI(3)*0.6
N173  NOVEMA:$
N174  [
N175        [select rotation and HOLD
N176  SPROT(1)=(RORMA~RANMA)&"HOLDA      [select rotation
N177  SPDIR(1)=RORMA&"RANMA        [direction of rotation
N178  UMAN=SPMOV(1)&IMUON                [enable spindle move
N179  [
N180  [...............spindle orient...................
N181  TIM19(10)=SPTOL(1)&SPORI(1)  [timer for end of orient
N182  IF(TUM19) SPORI(1)=0         [verify intoll for  1 sec.
N183  [
N184  [.............GEAR CHANGE..............................
N185  [Note: SPPND is set even if spindle is not within the
N186  [rev / min threshold (SPMOT) to change range "on the fly".
N187  GAM1=RM41~(SPEED<=SPSMG1(1))&"RM42       [request range 1
N188  GAM2=RM42~(SPEED>SPSMG1(1))&"RM41       [request range 2
N189  OKVG1=GAM1&"IMG1&IMUON&"SPMOT(1)        [range 1 selector control
N190  OKVG2=GAM2&"IMG2&IMUON&"SPMOT(1)        [range 2 selector control
N191  SPPND(1)=(GAM1&"IMG1)~(GAM2&"IMG2)&IMUON      [select hunt
N192  IF(IMG1) SPGAM(1)=1                          [select range 1
N193  IF(IMG2) SPGAM(1)=2                          [select range 2
N194  [
N195  [..................... axes management.......................
N196  TISBX(3)=MOVCN(1)                       [unclamp timer
N197  TISBY(3)=MOVCN(2)
N198  TISBZ(3)=MOVCN(3)
N199  TIBLX(5)=("MOVCN(1)&MOVCNP(1))~TDBLX     [clamp timer
N200  TIBLY(5)=("MOVCN(2)&MOVCNP(2))~TDBLY
N201  TIBLZ(5)=("MOVCN(3)&MOVCNP(3))~TDBLZ
N202  [
N203  UMOVE1=(MOVCN(1)~TDBLX)&IMUON                [enable axes
N204  UMOVE2=(MOVCN(2)~TDBLY)&IMUON
N205  UMOVE3=(MOVCN(3)~TDBLZ)&IMUON
N206  USFREX=MOVCN(1)&IMUON                    [unclamp axes
N207  USFREY=MOVCN(2)&IMUON
N208  USFREZ=MOVCN(3)&IMUON
N209  RDMOV(1)=(MOVCN(1)&"TDSBX)~TDBLX        [response from NC
N210  RDMOV(2)=(MOVCN(2)&"TDSBY)~TDBLY
N211  RDMOV(3)=(MOVCN(3)&"TDSBZ)~TDBLZ
N212  MOVCNP=MOVCN                                [MOVCN derivative
N213  [
N214  [.......................jog.....................
N215  [note: JOG must be enabled with NCMD=5, 8, 9
N216  SJOG=((NCMD=5)&"L7)~(NCMD=8)~(NCMD=9) [jog + and - enable
N217  L1=JOGP(1)
N218  L2=JOGM(1)
N219  L3=JOGP(2)
N220  L4=JOGM(2)
N221  L5=JOGP(3)
N222  L6=JOGM(3)
N223                            [home X Y Z positive direction
N224  JOGP(1)=P1&SJOG~RIC0X
N225  JOGM(1)=P2&SJOG
N226  JOGP(2)=P3&SJOG~RIC0Y
N227  JOGM(2)=P4&SJOG
N228  JOGP(3)=P5&SJOG~RIC0Z
N229  JOGM(3)=P6&SJOG
N230  MOVMA=JOGP~JOGM        [Select manual JOG
N231  [
N232  [................HANDWHEELS.....................
N233                            [select axis to be moved
```

```
N234  IF(P21) L21=”L21;L22=0;L23=0
N235  IF(P22) L22=”L22;L23=0;L21=0
N236  IF(P23) L23=”L23;L21=0;L22=0
N237  IF(L21) HWL(1)=1;L8=1
N238  IF(L22) HWL(1)=2;L8=1
N239  IF(L23) HWL(1)=3;L8=1
N240  IF(“L21&”L22&”L23) HWL(1)=0;L8=0
N241  [selezione passo
N242  IF(P24) L24=1;L25=0;L26=0
N243  IF(P25) L24=0;L25=1;L26=0
N244  IF(P26) L24=0;L25=0;L26=1
N245  IF(L24) STEP=1
N246  IF(L25) STEP=2
N247  IF(L26) STEP=3
N248  [
N249  [..............home cycle.....................
N250  [home cycle started by pressing softkey F17
N251  [terminated by BREAK or when all axes are homed.
N252  [cycle starts with Z axis then X, Y simultaneously.
N253  ZERIOK=MIZEA(1)&MIZEA(2)&MIZEA(3)
N254  L7=FF(P7&”L7),(ZERIOK~(NCMD<>5)~BRKA~P7&L7) [home cycle
N255  RIC0X=FF(L7&MIZEA(3)),(“L7~MIZEA(1)) [X home cycle in memory
N256  RIC0Y=FF(L7&MIZEA(3)),(“L7~MIZEA(2)) [Y home cycle in memory
N257  RIC0Z=FF(L7&(P6~P5)),(“L7~MIZEA(3))  [Z home cycle in memory
N258  [
N259  [softkey F7 menu 1 iniates the home cycle
N260  MICZE(1)=L7
N261  MICZE(2)=L7
N262  MICZE(3)=L7
N263  [assign physical home switches
N264  MIZER(1)=IMZX
N265  MIZER(2)=IMZY
N266  MIZER(3)=IMZZ
N267  [.............. manual tool change ..................
N268  ULAM06=CAUT&(TWM06>5)&”SPMOT(1)
N269  IF(IFICUT) CAUT=0
N270  TIM06(10)=”TUM06
N271  [
N272  [.....................lubrication ......................
N273  [The pump on (IMUON) frequency
N274  [depends on the movement of the axes.
N275  TLUBI(6000)=”TLUBU&IMUON&ILIVOL         [10 minute oscillator
N276  TLUBA=((MOVCN&”INTOL)=0)     [pause and disable if axes stopped
N277  UKLUBA=(TLUBW>5950)&”TLUBA&IMUON&ILIVOL   [pump for 5 seconds
N278  [
N279  [.....................general..............................
N280  [Note: ILIVRE e ILIVOL
N281  [     have no effect during the tapping fixed cycle (G84)
N282  FHOLD=((“ILIVRE~”ILIVOL)&(“G84~RAPI)) ~”ITERMI ~”IDRAOK ~ $
N283  “IDRMOK ~CAUT ~(SPRMP(1)~”IGIROK&SPROT(1))&”RAPI~SPORI(1)~ $
N284  SPPND(1) ~((NCMD<>5)&”ZERIOK)           [inibit axes movement
N285  DHOLD=FHOLD [inibits data blocks
N286  [
N287  RHOLD=FF(IHOLD&(“G84~RAPI)),(HOLDA)     [hold request
N288  LAHOLD=HOLDA                                  [hold lamp
N289  CYST=ISTART                              [start request
N290  LACYON=CYON                              [cycle ON lamp
N291  [
N292  [...................auxiliary ..................
N293  TIMUON(5)=IMUON              [derivative of power on
N294  RBRK=TDMUON                  [BREAK at power on
N295  CNOK=”EMEA~”TUMUON                [NC ready output
N296  REME=FF(“IMUON~”IOLTRC),(EMEA)     [emergency request
N297  [
N298  [...................break..................................
N299  IF(BRKA~EMEA) CALL RESET
N300  [
N301  IF(STBMD) SFKMEN=1     [recall menu SOFTK 1
N302  END
N303  [********************* VERY SLOW SECTION ****************
N304  [...................display.......................
N305  [
N306  WNDINT(2)=AUXH               [display H codes
N307  GIRMI=INT(ABS(SPTCH(1)))     [display effective speed
N308  [
N309  [.............. message preparation .....................
N310  SG(1)=”IMUON
N311  SG(2)=”ZERIOK&IMUON
N312  SG(3)=SG(2)&L7&”L5
```

```
N313  SG(4)=(SPRMP(1)~"IGIROK)&SPROT(1)
N314  SG(5)=SPPND(1)
N315  SG(6)="IDRAOK
N316  SG(7)="IDRMOK
N317  SG(8)="ILIVOL
N318  SG(9)="ILIVRE
N319  SG(10)="ITERMI
N320  SG(11)="IOLTRC
N321  SG(12)=CAUT
N322  SG(13)=(MOVCN<>RDMOV)
N323  CALL SCROLL      [recall message display
N324  END
N325  [********************* ROUTINES SECTION ********************
N326  [............... T functions.................................
N327  GEFUT:$
N328  CALL M05; CAUT=1 [manual tool change
N329  RTS
N330  [............... M functions.................................
N331  GEFUM:$
N332  WNDINT(1)=AUXM   [display code functions
N333  IF (AUXM=3) M03
N334  IF (AUXM=4) M04
N335  IF (AUXM=5) M05
N336  IF (AUXM=7) UREF=1; RTS           [coolant
N337  IF (AUXM=9) UREF=0; RTS           [stop coolant
N338  IF (AUXM=10) SSA=0; RTS
N339  IF (AUXM=11) CALL M11
N340  IF (AUXM=13) CALL M03; UREF=1; RTS      [M3 + ref.
N341  IF (AUXM=14) CALL M04; UREF=1; RTS      [M4 + ref.
N342  IF (AUXM=19) CALL M05; SPPOS(1)=0; SPORI(1)=1; RTS       [orient
N343  IF (AUXM=30) CALL M05; CALL RESET; RTS   [ NC reset
N344  IF (AUXM=40) CALL M05; RM41=0; RM42=0; RTS    [range auto
N345  IF (AUXM=41) CALL M05; RM41=1; RM42=0; RTS    [range 1
N346  IF (AUXM=42) CALL M05; RM42=1; RM41=0; RTS    [range 2
N347  RTS
N348  [
N349  M03: RORMA=1; RANMA=0; RTS              [spindle CW
N350  M04: RORMA=0; RANMA=1; RTS              [spindle CCW
N351  M05: RORMA=0; RANMA=0; RTS              [stop spindle
N352  M11: IF(AXPGM=0) SSA=00000111B; RTS; $
N353  ELSE SSA=AXPGM&00000111B; RTS           [unclamp axes
N354  [............ reset commands ..............................
N355  RESET:$
N356  RORMA=0; RANMA=0 [reset spindle rotation
N357  SPORI=0                     [reset spindle orient
N358  UREF=0                      [reset coolant
N359  CAUT=0                      [reset tool change in progress
N360  WNDINT(1)=30                [update M function display
N361  RTS
N362  [................. MESSAGE MANAGEMENT .......................
N363  SCROLL:$
N364  NM=1; NR=1
N365  LOOVIS:IF(NM>NMAX) CLRSCR
N366  IF(NR>16) RTS
N367  IF(SG(NM)) DISPL,NR,MSG(NM); NR=NR+1
N368  NM=NM+1; LOOVIS
N369  CLRSCR:IF(NR>16) RTS
N370  CLR,(NR); NR=NR+1; CLRSCR
N371  [.............. program end ............................
```

AXM11 - Selective axis clamping

```
N1   [*******************************************************
N2   [*    FUNCTION M11 SELECT AXIS SPECIFIED
N3   [*    ____________________
N4   [*               AXM11 941008
N5   [*******************************************************
N6   [
N7   [AXES X, Y, Z clamped or unclamped (M10 or M11)
N8   [AXIS 4°    Always clamped
N9   [*****************DECLARATION SECTION ********************
N10  [
N11  INP
N12  OUT
N13  UMOVE1                 [enable axis 1
N14  UMOVE2                 [enable axis 2
N15  UMOVE3                 [enable axis 3
N16  [
N17  INIT
N18  SSA=00000111B          [axes X, Y, Z always active and unclamped
N19  [
N20  PROG
N21  END
N22  [***************** SLOW SECTION **************************
N23  [PART SYNCHRONIZED with program blocks ________
N24  [ .......... decode auxilliary functions ..........
N25  IF(“BURDY)ASINC
N26  DHOLD=1; FHOLD=1
N27  IF(STROM) CALL GEFUM
N28  BURDY=0
N29  ASINC:$
N30  [
N31  [_____ ASYNCHRONOUS PART _________________
N32  [..................... axes management.....................
N33  UMOVE1=MOVCN(1)  [enabling X
N34  UMOVE2=MOVCN(2)  [enabling Y
N35  UMOVE3=MOVCN(3)  [enabling Z
N36  RDMOV=MOVCN      [axes enabled by the NC
N37  [................... general ............................
N38  FHOLD=0 [~ ..          [stop axes movement
N39  DHOLD=0 [~ ..          [stop program blocks
N40  END
N41  END
N42  [********************** ROUTINES SECTION ******************
N43  [ ........ decode M functions ..........................
N44  GEFUM:$
N45  WNDINT(1)=AUXM         [display M functions
N46  IF (AUXM=11) M11  [unclamp axes (selectivly)
N47  IF (AUXM=10) M10  [clamp axes
N48  RTS
N49  [
N50  M10: SSA=0; RTS
N51  M11: IF(AXPGM=0) SSA=00000111B; RTS; $
N52  ELSE SSA=AXPGM&00000111B; RTS
N53  [
N54  [...........program end.............................
```

AUXON - Auxiliaries control logic

```
N1   [*******************************************************
N2   [*
N3   [*          AUXILIARIES CONTROL LOGIC
N4   [*          ————————————————
N5   [*               AUXON 941008
N6   [*******************************************************
N7   [A CNOK output is expected that controls a relay in series
N8   [with the chain that turns on the auxiliaries.
N9   [
N10  [The NC does not see the auxiliaries ON pushbutton as an
N11  [input but as an input indicating the auxiliaries are ON.
N12  [
N13  INP
N14  IMUON            [machine on
N15  IDRAOK                [axis drives ok
N16  [
N17  OUT
N18  UMOVE1                [enable axis 1
N19  UMOVE2                [enable axis 2
N20  UMOVE3                [enable axis 3
N21  CNOK             [OK for auxiliaries from NC
N22  [
N23  STR
N24  MSG1             [auxiliaries OFF message
N25  [
N26  STIMER
N27  TIMUON,TUMUON,TDMUON,TAMUON,TWMUON      [Turn ON auxiliaries
N28  [
N29  INIT
N30  SSA=00000111B          [XYZ axes always enabled
N31  MSG1='AUXILIARIES OFF'
N32  [
N33  PROG
N34  END
N35  [***************** slow section ***************************
N36  UMOVE1=MOVCN(1)  [enable X axis
N37  UMOVE2=MOVCN(2)  [enable Y axis
N38  UMOVE3=MOVCN(3)  [enable Z axis
N39  RDMOV=MOVCN      [axes enabled response
N40  [
N41  POFO=ANI(1)      [axis feed override
N42  BURDY=0               [... function acquisition from NC
N43  [
N44  [...................turn on auxiliaries ..................
N45  TIMUON(5)=IMUON             [derivative at turn on
N46  RBRK=TDMUON                 [BREAK at turn on
N47  CNOK="EMEA~"TUMUON                [NC ready output
N48  REME=FF("IMUON~"IDRAOK),(EMEA)    [emergency request
N49  [
N50  IF("IMUON) DISPL,0, MSG1; ELSE CLR,0    [message display
N51  [
N52  [.............. program end ..............................
```

GEVOL3 - Single handwheel control of x, y, z axes

```
N1    [*********************************************************
N2    [*
N3    [*          HANDWHEEL SWITCHING EXAMPLE
N4    [*               GEVOL3      941008
N5    [*
N6    [*********************************************************
N7    [If only one handwheel is available it will need to be switched
N8    [between axes using an external selector or one created using
N9    [the softkeys as in this example.
N10   [
N11   [
N12   [
N13   [
N14   SOFTK
N15   P21,L21,'X AXIS HANDWHEEL'
N16   P22,L22,'Y AXIS HANDWHEEL'
N17   P23,L23,'Z AXIS HANDWHEEL'
N18   P24,L24,' 0.5 mm  per rev'
N19   P25,L25,'  1  mm  per rev'
N20   P26,L26,'  5  mm  per rev'
N21   P27,L27,' 10  mm  per rev'
N22   [
N23   INIT
N24   L25=1 [default at power up (softkey lights do not
N25   [           [hold state on power down)
N26   [
N27   PROG
N28   [axis selection softkey
N29   IF(P21) L21="L21;L22=0;L23=0 [softkey for X axis
N30   IF(P22) L22="L22;L23=0;L21=0 [softkey for Y axis
N31   IF(P23) L23="L23;L21=0;L22=0 [softkey for Z axis
N32   IF(L21) HWL(1)=1             [assign X axis handwheel 1
N33   IF(L22) HWL(1)=2             [assign Y axis handwheel 1
N34   IF(L23) HWL(1)=3             [assign Z axis handwheel 1
N35   IF("L21&"L22&"L23) HWL(1)=0  [no axis assigned
N36   [
N37   [softkey to select resolution (set in configuration)
N38   IF(P24) L24=1;L25=0;L26=0;L27=0    [1 handwheel rev = 0.5 mm (step1)
N39   IF(P25) L24=0;L25=1;L26=0;L27=0    [1 handwheel rev = 1 mm (step 2)
N40   IF(P26) L24=0;L25=0;L26=1;L27=0    [1 handwheel rev = 5 mm (step 3)
N41   IF(P27) L24=0;L25=0;L26=0;L27=1    [1 handwheel rev = 10 mm (step 4)
N42   IF(L24) STEP=1               [assign step 1
N43   IF(L25) STEP=2               [assign step 2
N44   IF(L26) STEP=3               [assign step 3
N45   IF(L27) STEP=4               [assign step 4
N46   [
N47   BURDY=0                     [...function acquisition from NC
N48   RDMOV=MOVCN                 [Axes enabled response
N49   END
N50   [.............. program end ............................
```

SPIND1 - Spindle rotation

```
N1   [*********************************************************
N2   [
N3   [     EXAMPLE OF SPINDLE ROTATION MANAGMENT
N4   [     WITH OR WITHOUT TRANSDUCER
N5   [     SPIND1      941008
N6   [
N7   [*********************************************************
N8   [
N9   [Automatic and manual spindle control (M3,M4,M13,M14)
N10  [Axes wait for spindle up to speed, spindle hold,
N11  [emergency if spindle not rotating.
N12  [In the wait for spindle up to speed both the NC signal and
N13  [the effective signal from the drive are considered.
N14  [
N15  INP
N16  IMAMAO                 [select manual spindle rotation clockwise
N17  IMAMAA                 [select manual spindle rotation anticlockwise
N18  ISTOPM                 [select stop spindle
N19  IGIROK                 [signal spindle upto speed
N20  [
N21  OUT
N22  TERM,4
N23  ABM                    [enable spindle operation
N24  [
N25  RAM,1
N26  ROTMA            [select rotation
N27  G84                    [record fixed cycle G84
N28  [
N29  STIMER
N30  TRMI,TRMU        [timer to verify spindle stopped for emergency
N31  [
N32  INIT
N33  SPGAM(1)=1       [range 1 (only)
N34  [
N35  PROG
N36  END
N37  IF(“BURDY) ASINC
N38  FHOLD=1; DHOLD=1
N39  IF(STROM) CALL GEFUM
N40  BURDY=0
N41  ASINC:$
N42  [
N43  [************** spindle management ************************
N44  [
N45  [— manual command
N46  IF (NCMD<>5) NOMANU
N47  IF (IMAMAO) CALL M03
N48  IF (IMAMAA) CALL M04
N49  IF (ISTOPM) CALL M05
N50  NOMANU:$
N51  [
N52  [—
N53  [If in automatic, speed equals S otherwise
N54  [force speed to max (SPSMAX).
N55  [Potentiometer 3 automatic:  from 70% to 130% of SPEED
N56  [                     tapping:  100%
N57  [                      manual: 0% to 100% of max SPEED
N58  G84=(CICFI=84)   [tapping in progress
N59  IF (NCMD=5) SPVEL(1)=SPSMAX(1); SPSSO(1)=ANI(3); NOVEMA
N60  SPVEL(1)=SPEED
N61  IF(G84) SPSSO(1)=1; $
N62  ELSE SPSSO(1)=0.7 + ANI(3)*0.6
N63  NOVEMA:$
N64  [
N65  SPROT(1)=ROTMA&”HOLDA        [select rotation and HOLD
N66  ABM=SPMOV(1)[&...            [enabling and consents
N67  [
N68  IF(BRKA~EMEA) CALL RESET           [break or emergency
N69  [
N70  [spindle with transducer in emergency if not in motion
N71  TRMI(5)=SPROT(1)&”SPMOT(1)&”SPREG(1)          [if active for 0.5 sec -> REME
N72  IF(TRMU) DISPL,0,’SPINDLE NOT ROTATING’       [display message
N73  IF(BRKA) CLR,0         [cancel msg
N74  [
N75  [— general ————————————————
N76  [Attention: The SPRMP(1) signal (spindle on ramp) is not
```

```
N77   [guaranteed to be immediately available after setting the
N78   [rotation control.
N79   [stop axis feed
N80   FHOLD = (SPRMP(1)~"IGIROK&SPROT(1))&"RAPI [~... &("G84~RAPI)
N81   DHOLD = FHOLD [~
N82   REME  = FF(TRMU),(EMEA)      [emergency; spindle stopped
N83   END
N84   [ ............... very slow section .......................
N85   GIRMI=INT(ABS(SPTCH))        [display S
N86   END
N87   [
N88   [— ROUTINES ————————————————————
N89   GEFUM: $
N90   WNDINT(1)=AUXM               [display M functions
N92   IF(AUXM=4) M04
N93   IF(AUXM=5) M05
N94   RTS
N95   M03: SPDIR(1)=0; ROTMA=1; RTS
N96   M04: SPDIR(1)=1; ROTMA=1; RTS
N97   M05: ROTMA=0; RTS
N98   [
N99   RESET: $
N100  ROTMA=0                      [stop spindle
N101  WNDINT(1)=30                 [display M30
N102  RTS
N103  [..................... program end .......................
```

SPIND2 - Spindle Orient

```
N1   [*******************************************************
N2   [
N3   [          EXAMPLE OF SPINDLE ORIENT MANAGEMENT
N4   [                SPIND2     941008
N5   [
N6   [*******************************************************
N7   [
N8   [Automatic spindle orient
N9   [angle is programmable with H function.
N10  INP
N11  [
N12  OUT
N13  TERM,4
N14  ABM                    [enable spindle operation
N15  [
N16  STIMER
N17  TM19I,TM19U,TM19D,TM19A,TM19C      [timer verifying in position tolerance
N18  [
N19  INIT
N20  SPGAM(1)=1                         [range 1 (only)
N21  [
N22  PROG
N23  END
N24  IF(“BURDY) ASINC
N25  FHOLD=1; DHOLD=1
N26  IF(STROH) CALL GEFUH
N27  IF(STROM) CALL GEFUM
N28  BURDY=0
N29  ASINC:$
N30  [
N31  [*** spindle management ***********************************
N32  IF(BRKA~EMEA) CALL RESET           [break or emergency
N33  [
N34  TM19I(20)=SPTOL(1)&SPORI(1)  [verify tolerance for 2 sec.
N35  IF(TM19U) SPORI(1)=0         [reset orient control
N36  [
N37  ABM=SPMOV(1)[&...            [enables and consents
N38  [
N39  [— general ————————————————
N40  DHOLD = SPORI(1)             [hold subsequent data blocks
N41  FHOLD = DHOLD                      [hold axis feed
N42  END
N43  [ ............... very slow section ........................
N44  END
N45  [
N46  [— ROUTINES ———————————————
N47  GEFUH: SPPOS(1)=(IFP(AUXH)/360)//1.0; RTS
N48  [     note: SPPOS must have a value between 0 and 1
N49  [     it represents an angle (0 - 360)
N50  [
N51  GEFUM: $
N52  WNDINT(1)=AUXM                     [display M functions
N53  IF(AUXM=19) M19
N54  RTS
N55  M19:SPROT(1)=0
N56  [If unidirectional is required set
N57  [SPORP(1) or SPORM(1) before SPORI(1)!
N58  SPORI(1)=1
N59  RTS
N60  RESET:$
N61  SPORI=0
N62  WNDINT(1)=30                      [display M30
N63  RTS
N64  [................. program end ............................
```

SPIND3 - Range change

```
N1   [*******************************************************
N2   [
N3   [     EXAMPLE SPINDLE WITH TWO RANGES
N4   [                SPIND3      941008
N5   [
N6   [*******************************************************
N7   [
N8   [spindle range change management
N9   INP
N10  IMG1             [microswitch range 1
N11  IMG2             [microswitch range 2
N12  ISGLMI           [threshold spindle speed
N13  [
N14  OUT
N15  TERM,4
N16  ABM              [enable spindle operation
N17  KVG1             [select actuator range 1
N18  KVG2             [select actuator range 2
N19  [
N20  RAM,1
N21  GAM1             [range 1 selected
N22  GAM2             [range 2 selected
N23  MM41             [force range 1
N24  MM42             [force range 2
N25  [
N26  PROG
N27  END
N28  IF(“BURDY) ASINC
N29  FHOLD=1; DHOLD=1
N30  IF(STROM) CALL GEFUM
N31  BURDY=0
N32  ASINC:$
N33  [
N34  [*** spindle management ***********************************
N35  [
N36  GAM1=MM41~(SPEED<SPSMG1(1))&”MM42       [select range 1
N37  GAM2=MM42~(SPEED>=SPSMG1(1))&”MM41      [select range 2
N38  [
N39  [attivate actuator only at min spindle RPM (threshold)
N40  KVG1=GAM1&”IMG1&”ISGLMI&”SPMOT(1)       [select actuator range 1
N41  KVG2=GAM2&”IMG2&”ISGLMI&”SPMOT(1)       [select actuator range 2
N42  [
N43  IF(IMG1) SPGAM=1                        [select range 1
N44  IF(IMG2) SPGAM=2                        [select range 2
N45  [attenzione: SPGAM=0 does not allow hunting
N46  [
N47  SPPND(1)=(GAM1&”IMG1)~(GAM2&”IMG2)      [spindle hunt
N48  [Note: RANGE CHANGE “ON THE FLY”
N49  [     SPPND has priority over the other controls;
N50  [     if a range change is requested while the spindle
N51  [     is moving. The spindle is decelerated to threshold speed
N52  [     before hunting is activated.
N53  [
N54  [
N55  ABM=SPMOV(1)[&...            [enable and consents
N56  [
N57  [— general ————————————————
N58  DHOLD = SPPND(1)             [hold subsequent data blocks
N59  FHOLD = DHOLD                     [axis feed hold
N60  END
N61  [ ............... very slow section ........................
N62  IF(SPPND(1)) DISPL,0,’GEAR CHANGE IN PROGRESS’; ELSE CLR,0
N63  END
N64  [
N65  [— ROUTINES ————————————————
N66  GEFUM: $
N67  IF (AUXM=40) MM41=0; MM42=0; RTS
N68  IF (AUXM=41) MM41=1; MM42=0; RTS
N69  IF (AUXM=42) MM41=0; MM42=1; RTS
N70  RTS
N71  [.................. program end.........................
```

LUBMET - Lubrication based on axis travel

```
N1   [*********************************************************
N2   [*         LUBRICATION on distance travelled
N3   [*         ________________
N4   [*               LUBMET     941008
N5   [*********************************************************
N6   [
N7   INP
N8   IMUON            [auxiliaries on
N9   ILIVOL                [oil level
N10  [
N11  OUT
N12  ABILX            [enable axis X
N13  ABILY            [enable axis Y
N14  ABILZ            [enable axis Z
N15  UKLUBA                [axes lube actuator
N16  [
N17  RAM,32
N18  CORSAX                [time and distance X
N19  CORSAY                [time and distance Y
N20  CORSAZ                [time and distance Z
N21  POAOLX                [absolute position X (old)
N22  POAOLY                [absolute position Y (old)
N23  POAOLZ                [absolute position Z (old)
N24  ML                    [Max time interval for lube
N25  [
N26  STR
N27  MSG1             [message- level insufficient
N28  MSG2             [message- auxiliary not active
N29  [
N30  STIMER
N31  TLUBI,TLUBU,TLUBD,TLUBA,TLUBW      [lube
N32  [
N33  SOFTK,1
N34  P1,L1,1,'LUBRIFICA'
N35  [
N36  INIT
N37  ML=15000         [time to go before initial lube
N38  MSG1='OIL LEVEL INSUFFICIENT'
N39  MSG2='AUXILIARY NOT ACTIVE'
N40  [
N41  PROG
N42  END
N43  [
N44  [.....................lube ......................
N45  [lube when at least one axis has moved ML meters
N46  TLUBI(50)=(CORSAX>ML)~(CORSAY>ML)~(CORSAZ>ML)~TLUBD
N47  [distance travelled is incremented only when axes are
N48  [moving and outside the in position tolerance.
N49  [
N50  [
N51  IF("INTOL(1)&MOVCN(1)) CORSAX=CORSAX+ABS(POA(1)-POAOLX)
N52  IF("INTOL(2)&MOVCN(2)) CORSAY=CORSAY+ABS(POA(2)-POAOLY)
N53  IF("INTOL(3)&MOVCN(3)) CORSAZ=CORSAZ+ABS(POA(3)-POAOLZ)
N54  POAOLX=POA(1)          [update old positions
N55  POAOLY=POA(2)
N56  POAOLZ=POA(3)
N57  [after each lubrication reset the distance travelled
N58  IF(TLUBU) CORSAX=0; CORSAY=0; CORSAZ=0
N59  [with "IMUON load max on CORSA so lubrication is performed
N60  [on power up
N61  [same thing on NO OIL
N62  IF("IMUON~"ILIVOL) CORSAX=ML; CORSAY=ML; CORSAZ=ML
N63  [
N64  [lube for 5 seconds or on softkey P1
N65  [
N66  UKLUBA=(TLUBD~P1)&ILIVOL&IMUON     [lube pump
N67  L1 = UKLUBA                        [lube lamp
N68  [
N69  [.....................general.............................
N70  ABILX=MOVCN(1)               [enable axes
N71  ABILY=MOVCN(2)
N72  ABILZ=MOVCN(3)
N73  RDMOV=MOVCN            [axes enabled response
N74  BURDY=0                      [acquire NC function
N75  POFO=ANI(1)            [feed override
N76  FHOLD="ILIVOL                [inhibit axes move
```

```
N77   DHOLD=FHOLD            [inhibit data blocks
N78   REME=FF(“IMUON),(EMEA) [machine emergency
N79   [
N80   END
N81   IF(“ILIVOL) DISPL,1, MSG1; ELSE CLR,1    [message-level min.
N82   IF(“IMUON) DISPL,2, MSG2; ELSE CLR,2     [message aux
N83   END
N84   [.............. program end ..........................
```

LUBIN3 - Basic intermittent lubrication

```
N1   [***********************************************
N2   [*
N3   [*          INTERMITENT LUBRICATION
N4   [*               LUBIN3      941010
N5   [*
N6   [***********************************************
N7   [============ example 1 ======================
N8   [
N9   [UPOMPA is activated for 5 seconds each 10 minutes
N10  [
N11  OUT
N12  UPOMPA                 [select pump
N13  [
N14  STIMER
N15  TLI,TLU,TLD,TLA,TLW    [cycle timer
N16  [
N17  PROG
N18  TLI(6000)=”TLU   [oscillator (600 seconds)
N19  UPOMPA=(TLW>5950)[activate for 5 sec.
N20  END
N21  [.................. programma end 1 ......................
N22  [
N23  [
N24  [========== example 2 =========================
N25  [To obtain LONG TIMES from 1 hour to “ 2 years “
N26  [a timer must be combined with a counter. This
N27  [example activates the pump for 5 seconds every 60 minutes.
N28  [
N29  OUT
N30  UPOMPA                 [pump control
N31  [
N32  STIMER
N33  TLI,TLU,TLD,TLA,TLW    [clock timer
N34  COUNT
N35  CLZ,CLA,CLI,CLC,CLW    [second counter
N36  [
N37  INIT
N38  CLZ(3600)=1      [preset counter to 3600 sec
N39  CLZ(3600)=0
N40  [
N41  PROG
N42  TLI(10)=”TLU           [1 sec oscillator
N43  CLA=TLU                [count
N44  POMPA=(CLW<5)          [activate pump for 5 sec
N45  END
N46  [.................. program end 2 ......................
```

LUBMOV - Lubrication timed only when axes are moving

```
N1   [*******************************************************
N2   [*    LUBRICATION timer on only when axes moving
N3   [*          ________________
N4   [*                LUBMOV      941010
N5   [*******************************************************
N6   [
N7   INP
N8   IMUON             [auxiliaries on
N9   ILIVOL                 [oil level
N10  [
N11  OUT
N12  ABILX             [enable axis X
N13  ABILY             [enable axis Y
N14  ABILZ             [enable axis Z
N15  UKLUBA                 [axes lube actuator
N16  [
N17  STR
N18  MSG1              [low oil level message
N19  MSG2              [auxiliaries not on message
N20  [
N21  STIMER
N22  TLUBI,TLUBU,TLUBD,TLUBA,TLUBW           [lubrication
N23  [
N24  SOFTK,1
N25  P1,L1,1,' MANUAL LUBE'
N26  [
N27  INIT
N28  MSG1=' OIL LEVEL INSUFFICENT'
N29  MSG2='AUSILIARI NON INSERITI'
N30  [
N31  PROG
N32  END
N33  [
N34  [...................lubrication .....................
N35  [On power up (IMUON) time is reset so lube is done
N36  [during the first move.
N37  [Time is counted only when the axes are moving.
N38  TLUBI(6000)="TLUBU&IMUON&ILIVOL    [10 minute oscillator
N39  [pause when axes stopped or disabled
N40  TLUBA=((MOVCN&"INTOL)=0)
N41  [pump for 5 seconds or with softkey P1
N42  UKLUBA=((TLUBW>5950)&"TLUBA~P1)&IMUON&ILIVOL
N43  L1 = UKLUBA [lubrication lamp
N44  [
N45  [...................general.............................
N46  ABILX=MOVCN(1)         [enable axes
N47  ABILY=MOVCN(2)
N48  ABILZ=MOVCN(3)
N49  RDMOV=MOVCN       [axes enabled response
N50  BURDY=0                [... acquire NC function
N51  POFO=ANI(1)       [feed override potentiometer
N52  [
N53  [If the iol level is low the program is halted at the next
N54  ["rapid" block or at the first auxiliary function.
N55  FHOLD="ILIVOL          [inibit axes move
N56  DHOLD=FHOLD       [inibit data blocks
N57  REME=FF("IMUON),(EMEA) [machine emergency
N58  [
N59  END
N60  [......... very slow section ............................
N61  IF("ILIVOL) DISPL,1, MSG1; ELSE CLR,1    [message- level min.
N62  IF("IMUON) DISPL,2, MSG2; ELSE CLR,2     [message- aux
N63  END
N64  [................ program end ..........................
```

ZERIAX - Automatic home axes cycle

```
N1   [*********************************************************
N2   [*     EXAMPLE OF AUTOMATIC HOME CYCLE XYZ
N3   [*          ___________________
N4   [*                       ZERIAX      941008
N5   [*********************************************************
N6   [
N7   [Automatic home cycle for axes with non-absolute transducers
N8   [
N9   [First Z is homed in the + direction then
N10  [X and Y are homed simultaneously in the + direction.
N11  [
N12  [***************** DECLARATION SECTION ********************
N13  [
N14  [     physical inputs
N15  INP
N16  IMZX              [home microswitch X
N17  IMZY              [home microswitch Y
N18  IMZZ              [home microswitch Z
N19  [
N20  [     physical outputs
N21  OUT
N22  UMOVE1                 [enable axis X
N23  UMOVE2                 [enable axis Y
N24  UMOVE3                 [enable axis Z
N25  [
N26  [     internal variables
N27  RAM,1
N28  RIC0X             [homing X in process
N29  RIC0Y             [homing Y in process
N30  RIC0Z             [homing Z in process
N31  ZERIOK                 [axes homed
N32  [
N33  [     message strings
N34  STR
N35  MSG1              [message- axes not homed
N36  MSG2              [message- JOG Z+ to start cycle
N37  [
N38  SOFTK,1
N39  P1,L1,1,'JOG AXIS X+'
N40  P2,L2,1,'JOG AXIS X-'
N41  P3,L3,1,'JOG AXIS Y+'
N42  P4,L4,1,'JOG AXIS Y-'
N43  P5,L5,1,'JOG AXIS Z+'
N44  P6,L6,1,'JOG AXIS Z-'
N45  P7,L7,  ' HOME   AXES'
N46  [
N47  [***************** INITIALIZATION SECTION ***************
N48  INIT
N49  [initialization messages
N50  MSG1='HOME AXES'  [homing message
N51  MSG2='JOG Z+ to start cycle'
N52  [
N53  PROG
N54  [***************** FAST SECTION ************************
N55  [ ................ reading potentiometers...................
N56  POFO=ANI(1)      [automatic feed
N57  [If homing not completed reduce manual speed to 1/5
N58  IF(ZERIOK) $
N59  POMO(1)=ANI(2); $
N60  POMO(2)=POMO(1); $
N61  POMO(3)=POMO(2); $
N62  ELSE $
N63  POMO(1)=ANI(2)/5; $
N64  POMO(2)=POMO(1); $
N65  POMO(3)=POMO(1)
N66  END
N67  [***************** SLOW SECTION *************************
N68  [ .......... decode auxilliary functions ..........
N69  BURDY=0                [... acquire NC function
N70  [
N71  [ ................ enable axes .......................
N72  UMOVE1=MOVCN(1)
N73  UMOVE2=MOVCN(2)
N74  UMOVE3=MOVCN(3)
N75  RDMOV=MOVCN
N76  [.........................jog.............................
```

```
N77   [when homing only JOG + allowed
N78   L1=(P1&”L7)~RIC0X      [softk jog x+ lamp
N79   L2=P2&”L7                   [softk jog x- lamp
N80   L3=(P3&”L7)~RIC0Y      [softk jog y+ lamp
N81   L4=P4&”L7                   [softk jog y+ lamp
N82   L5=(P5&”L7)~RIC0Z      [softk jog z+ lamp
N83   L6=P6&”L7                   [softk jog z+ lamp
N84   [
N85   JOGP(1)=L1
N86   JOGM(1)=L2
N87   JOGP(2)=L3
N88   JOGM(2)=L4
N89   JOGP(3)=L5
N90   JOGM(3)=L6
N91   MOVMA=JOGP~JOGM  [select manual JOG
N92   [
N93   [..............home cycle.....................
N94   [Cycle started manually by pressing P7 (softk)
N95   [homing command
N96   ZERIOK=(MIZEA(1)&MIZEA(2)&MIZEA(3))
N97   L7=FF(P7),(P7&L7~(NCMD<>5)~BRKA~ZERIOK)
N98   [
N99   [store state of home cycle
N100  RIC0Z=FF(P5&L7),(“L7~MIZEA(3))
N101  RIC0X=FF(MIZEA(3)),(“L7~MIZEA(1))
N102  RIC0Y=FF(MIZEA(3)),(“L7~MIZEA(2))
N103  [
N104  [home cycle using home switch
N105  MICZE(1)=L7
N106  MICZE(2)=L7
N107  MICZE(3)=L7
N108  [assign home swiches
N109  MIZER(1)=IMZX
N110  MIZER(2)=IMZY
N111  MIZER(3)=IMZZ
N112  [
N113  [home cycle without using home switch
N114  [substitute MARK() for MICZE() and do not assign MIZER()
N115  [MARK(1)=L7
N116  [MARK(2)=L7
N117  [MARK(3)=L7
N118  [.....................general..............................
N119  FHOLD=(NCMD<>5)&”ZERIOK
N120  DHOLD=0 [...
N121  END
N122  [********************** VERY SLOW SECTION ****************
N123  IF (“ZERIOK)  DISPL, 0, MSG1; ELSE CLR, 0      [homing message
N124  IF (“ZERIOK&L7) DISPL,1, MSG2; ELSE CLR,1      [start cycle message
N125  [
N126  END
N127  [................... program end .........................
```

ESRNDCU - Random tool change with load / unload in masked time

```
N1   [*********************************************************
N2   [*    ASYNCHRONOUS RANDOM TOOL CHANGE
N3   [*    CHAIN with 24 tools and quick search
N4   [*          ________________
N5   [*          ESRNDCU     9401008
N6   [*********************************************************
N7   [
N8   [****** PROGRAMS WITH X AXIS MOVMENTS RUN BY THE PLC *****
N9   [CUAUTO:
N10  [P1=100     [X position for tool change
N11  [P2=-100    [Y position for tool change
N12  [P3=150     [Z safe height
N13  [P4=50      [Z position for tool change
N14  [
N15  [_____________________________
N16  [O0         [absolute origin
N17  [M26        [sequence 4 manual unloading
N18  [M62        [open storage cover
N19  [ZP3RM19    [Z safe height and spindle orient
N20  [XP1YP2R    [X Y in position
N21  [ZP4R [Z to change position
N22  [M... [M function for tool change
N23  [G4K5 [0.5 sec
N24  [...
N25  [O-1        [reset origin
N26  [M29        [activate compensation
N27  [M63        [close storage cover
N28  [M34        [end of tool change
N29  [.............. end program ............................
N30  [_________ end CUAUTO _______________
N31  [
N32  [CUMANU:
N33  [M26        [manual tool change
N34  [M29        [activate compensation
N35  [M34        [end of tool change
N36  [_____________________________
N37  [
N38  [CORR:
N39  [M29        [activate compensation
N40  [M34        [end of tool change
N41  [_____________________________
N42  [
N43  INP
N44  IAUXON            [ 1 auxiliaries on
N45  IZERM       [ 2 tool changer zero switch
N46  IRIMAA            [ 3 storage door open
N47  IRIMAC            [ 4 storage door closed
N48  [...  [ others ...
N49  [
N50  OUT
N51  ABX         [ 1 enable axis X
N52  ABY         [ 2 enable axis Y
N53  UABMAG      [ 3 enable changer
N54  ABZ         [ 4 enable axis Z
N55  UARIMA      [ 5 output for door opening
N56  UCRIMA      [ 6 output for door closing
N57  [...  [ others ...
N58  RAM,16
N59  PORIT [final position for changer
N60  [
N61  RAM,1
N62  RICUT [changer positioning cycle in progress
N63  INPOS [changer in valid position
N64  ERRM06      [M6 programmed without T funct.
N65  [           [stored commands for automatic tool changer
N66  MM26        [manual tool change
N67  MM62        [open storage door
N68  MM63        [close storage door
N69  MM66        [halt unload sequence
N70  CIM6        [M06 cycle in progress
N71  [...  [others ...
N72  STR
N73  MSG(10)     [text for messages and alarms
N74  [
N75  STIMER
N76  TIRIC,TURIC,TDRIC,TARIC,TWRIC      [validation of SGLP2P
```

```
N77   [
N78   SOFTK,1
N79   [           '+————+————+————'
N80   P1,CUAUT,   'change     tool AUTOMATIC'
N81   P2,CUMAN,   'change     tool MANUAL'
N82   P3,L3,            ''
N83   P4,L4,            'end TC     manual'
N84   P5,L5,            ''
N85   P6,L6,            ''
N86   P7,L7,            'RESET TC'
N87   P8,L8,            ''
N88   [
N89   [
N90   INIT  [INITIALIZATION SECTION
N91   [
N92   MSG(1)= 'VERIFY TOOL TABLE AND RESET TC'
N93   MSG(2)= 'change tool manually'
N94   MSG(3)= 'M6 programmed without Txx'
N95   MSG(4)= 'waiting for storage door to open'
N96   MSG(5)= 'waiting for storage door to close'
N97   [
N98   SSA=00000111B                [XYZ always active
N99   [
N100  [***** TOOL CHANGER SEQUENCE DEFINITION ********
N101  [... TC SEQUENCE TO LOAD TOOL FROM FLOOR, SPINDLE EMPTY ...
N102  DEF SEQCU(1)=-6,-16,-34,COM,1,'CUMANU'
N103  [
N104  [...TC SEQUENCE TO UNLOAD FROM SPINDLE TO FLOOR(T0M6) ...
N105  DEF SEQCU(2)=-6,-10,-34,COM,1,'CUMANU'
N106  [
N107  [...TC SEQUENCE FOR EXCHANGE BETWEEN SPINDLE AND FLOOR ...
N108  DEF SEQCU(3)=-6,-10,-16,-34,COM,1,'CUMANU'
N109  [
N110  [...TC SEQ.TO UNLOAD TO FLOOR AND LOAD FROM STORAGE ...
N111  DEF SEQCU(4)=-1,901,-5,-6,-10,-17,-34,COM,1,'CUAUTO'
N112  [
N113  [...TC SEQ. TO UNLOAD TO STORAGE AND LOAD FROM FLOOR...
N114  DEF SEQCU(5)=-23,923,-6,-12,-16,66,26,-27,-34,COM,1,'CUAUTO'
N115  [
N116  [...TC SEQUENCE TO EXCHANGE TOOL WITH ONE IN SPINDLE...
N117  DEF SEQCU(6)=-1,901,-5,-6,-12,-17,66,-23,923,-27,-34, $
N118  COM,1,'CUAUTO'
N119  [
N120  [...TC SEQUENCE TO LOAD FROM STORAGE WITH EMPTY SPINDLE...
N121  DEF SEQCU(7)=-1,901,-5,-6,-17,-34, $
N122  COM,1,'CUAUTO'
N123  [
N124  [...TC SEQUENCE TO UNLOAD TOOL FROM SPINDLE TO STORAGE....
N125  DEF SEQCU(8)=-23,923,-6,-12,66,-27,-34, COM,1,'CUAUTO'
N126  [
N127  [...TC SEQUENCE TO LOAD TOOL = TOOL IN SPINDLE ...
N128  DEF SEQCU(11)=-6,-34,COM,1,'CORR'
N129  [
N130  [... T programmed after a T (during the M06 wait) ...
N131  [... return JAWS to storage and re-analyze situation ...
N132  DEF SEQCU(19)=923,-23,-31,0
N133  [
N134  [NOTE: if there is the possibility to move the changer
N135  [     with JOGCU after the changer has already been positioned
N136  [     automatically it will be necessary to do a
N137  [     position search (901) or (923) after the -6.
N138  [
N139  PROG  [FAST SECTION
N140  END   [SLOW SECTION
N141  ABX=MOVCN(1)                 [enable axes
N142  ABY=MOVCN(2)
N143  ABZ=MOVCN(3)
N144  RDMOV=MOVCN
N145  POFO=ANI(1)            [feed override potentiometer
N146  [
N147  [
N148  [————————SYNCHRONIZED PART————————
N149  [
N150  IF("BURDY)ASINC
N151  FHOLD=1; DHOLD=1
N152  [decoding always requires a T first then M
N153  IF(STROT)CALL GEFUT
N154  IF(STROM)CALL GEFUM
N155  BURDY=0
```

```
N156  ASINC:$
N157  [————————ASYNCHRONOUS PART————————————
N158  [*****************************************************
N159  [     AUTOMATIC TC MANAGEMENT      *
N160  [*****************************************************
N161  CALL CUAUTO      [automatic TC routine
N162  [
N163  CALL POSMAG
N164  [.......... physical movements for tool change ...........
N165  [safety controls for the changer movements must always be
N166  [put directly in the control outputs; for example:
N167  [out  =((select_auto) ~ (select_man))    & safety_mech.
N168  [
N169  UARIMA=MM62            [&... safety.
N170  UCRIMA=MM63            [&... safety.
N171  [...
N172  L4=MM26                [manual tool change in progress
N173  [...
N174  [
N175  [reset memory at end of selection (comands completed)
N176  IF(IRIMAA&"IRIMAC) MM62=0    [door open
N177  IF(IRIMAC&"IRIMAA) MM63=0    [door closed
N178  IF(P4)  MM26=0                    [ok end manual TC
N179  [*****************************************************
N180  [     OTHER ASYNCHRONOUS CONTROLS  *
N181  [*****************************************************
N182  [
N183  [...
N184  [...
N185  [
N186  [*****************************************************
N187  [     ALLARMS,CONSENTS AND SAFETIES      *
N188  [*****************************************************
N189  [related to the NC
N190  DHOLD=EMACU~MM26~MM62~MM63~EMAP2P(1)     [ ~...
N191  FHOLD=DHOLD                  [ ~...
N192  REME=FF("IAUXON),(EMEA) [ ~...     [emergency request to NC
N193  [
N194  END
N195  [————————— VERY SLOW SECTION ————————
N196  [.............message display .................
N197  IF(EMACU)  DISPL,1,MSG(1); ELSE CLR,1    [NC emergency
N198  IF(MM26) DISPL,2,MSG(2); ELSE CLR,2      [manual TC
N199  IF(ERRM06) DISPL,3,MSG(3); ELSE CLR,3    [M6 without T ready
N200  IF(MM62) DISPL,4,MSG(4); ELSE CLR,4      [wait for door open
N201  IF(MM63) DISPL,5,MSG(5); ELSE CLR,5      [wait for door close
N202  [
N203  WINDOW=IFP(UTSPCU)     [Display tool in spindle
N204  ASCW=116               [Code for 't'character
N205  [The display can be very useful if you use alternate
N206  [corrections (the T window in the display is the active
N207  [control not the tool).
N208  [
N209  END
N210  [
N211  [————————— ROUTINES SECTION —————————
N212  [
N213  [*****************************************************
N214  [                      T FUNCTION  *
N215  [*****************************************************
N216  GEFUT:$
N217  [.......Activate alternate correction .............
N218  [Applicable only if you use tool families:
N219  [tool codes greater than 100 (must already be in the tool table)
N220  [can be interpreted:
N221  [
N222  IF(TOOL>100) OFST=TOOL; INTOF=1; RTS
N223  [
N224  [.............. TOOL CHANGE CALL ...........
N225  UTECU=TOOL  [inform TC module of the desired tool
N226  NEWCU=1           [request activation of the TC module
N227  RTS
N228  [
N229  [*****************************************************
N230  [     M FUNCTIONS *
N231  [*****************************************************
N232  GEFUM:$
N233  WNDINT(1)=AUXM
N234  IF(AUXM=6)  M06
```

```
N235  IF(AUXM=30) CALL RESET; RTS
N236  IF(“CUATT) RTS
N237  IF(AUXM=62) MM62=1; RTS
N238  IF(AUXM=63) MM63=1; RTS
N239  IF(AUXM=26) M26
N240  IF(AUXM=29) INTOF=1; RTS
N241  IF(AUXM=34) CUATT=0; CIM6=0; RTS
N242  RTS
N243  [
N244  M06:$
N245  IF(“CUATT) ERRM06=1; RTS     [M6 without T
N246  M6PGM=1; CIM&=1
N247  RTS
N248  [
N249  M26:$
N250  IF(NSEQCU<5) MM62=1; RTS     [manual TC only in SEQ 1,2,3,4
N251  RTS
N252  [
N253  [*****************************************************
N254  [     AUTOMATIC TOOL CHANGE CONTROL      *
N255  [*****************************************************
N256  [.................. select TC mode ...................
N257  CUAUTO:$
N258  IF(CUATT) NOSELE
N259  IF(P1) SELECU=0         [automatic TC (default)
N260  IF(P2) SELECU=1         [manual TC (no storage)
N261  NOSELE:$
N262  [
N263  [mode selection softkey lights
N264  CUAUT=(SELECU=0)
N265  CUMAN=(SELECU=1)
N266  [
N267  [*****************************************************
N268  [... interrupt sequence, cancellation, emergency ....
N269  [
N270  [The TC is interrupted only if:
N271  [- the auxilliaries are turned off during a TC (not during M6 wait)
N272  [- a BREAK command is sent during the change sequence
N273  [
N274  [The interrupt is made with REMCU and the TC
N275  [responds by activating EMACU
N276  REMCU=FF(((BRKA&CIM6)~(“IAUXON&CUATT))&(OPERCU<>-6)),(EMACU)
N277  [
N278  [The P7 softkey executes RBKCU to exit from EMACU (emergency)
N279  IF(P7&EMACU) RBKCU=1; RBRK=1  [cancel TC emergency
N280  [
N281  [After an interrupt it is to reset the TC with the appropriate
N282  [softkey after having VERIFIED THE TOOL TABLE.
N283  L7=EMACU               [TC emergency lamp
N284  [
N285  IF(EMACU) CALL RESECU  [reset PLC commands
N286  [
N287  [*****************************************************
N288  [...... decode sequence codes ......
N289  IF (“BRDYCU) NOCU
N290  MAPRCU=0               [halt cycle
N291  CALL OPER              [management TC cycle
N292  BRDYCU=0               [TC cycle acquired
N293  NOCU:$
N294  [
N295  [*****************************************************
N296  [............ OK to continue cycle .................
N297  IF(“CUATT) MM66=0 [synchronous part completed with M6
N298  [                     [ok start unload in masked time
N299  MAPRCU=”MM66&”RICUT    [&”... &”...
N300  [
N301  RTS
N302  [************ RETURN FROM CUAUTO CONTROL ***************
N303  [
N304  [*****************************************************
N305  [     ROUTINE TO DECODE TC AND RESET     *
N306  [*****************************************************
N307  [case for TC reset
N308  RESECU:$
N309  MM26=0                 [reset tool change
N310  MM62=0
N311  MM63=0
N312  MM66=0
N313  RICUT=0
```

```
N314  CIM6=0
N315  [normal reset (M30 or break)
N316  RESET:$
N317  WNDINT(1)=30     [display M30
N318  ERRM06=0         [cancel error on M6 (M6 without T ready)
N319  RTS
N320  [————————————————————————
N321  [TC OPERATIONS management
N322  OPER:$
N323  IF(OPERCU=26) CU26
N324  IF(OPERCU=66) CU66
N325  IF(OPERCU=901) CU901
N326  IF(OPERCU=923) CU923
N327  [...
N328  RTS
N329  [manual tool change (sequence 5 only)
N330  CU26:$
N331  MM26=1
N332  RTS
N333  [
N334  [wait for end of tool change (synchronous part)
N335  CU66:$
N336  MM66=1
N337  RTS
N338  [
N339  [search for place to load
N340  CU901:$
N341  PORIT=PPRECU
N342  RICUT=1
N343  RTS
N344  [search for place to unload
N345  CU923:$
N346  PORIT=PPOSCU
N347  RICUT=1
N348  RTS
N349  [
N350  [*****************************************************
N351  [     CHANGER POSITIONING: POINT TO POINT AXIS *
N352  [*****************************************************
N353  [if position is OK RICUT is reset
N354  POSMAG:$
N355  SSAP2P(1)=1            [changer always enabled
N356  UABMAG=MOVP2P(1)       [enable changer axis
N357  RDMP2P(1)=MOVP2P(1)          [response axis enabled
N358  INPOS=SGLP2P(1)&MZAP2P(1)&”RUNP2P(1)&”RICUT&”EMAP2P(1)[pos. ok
N359  [
N360  IF(“RICUT) RTS               [no need for positioning
N361  POTP2P(1)=1            [speed potentiometer
N362  MIZP2P(1)=IZERM        [changer home switch
N363  IF(“MZAP2P(1)) ZEMAG   [test axis zeroed (homed)
N364  JGPP2P(1)=0            [if zeroed reset JOG
N365  MCZP2P(1)=0            [if zeroed reset zero search
N366  [calculate position to be reached (via shortest path)
N367  PFNP2P(1)=IFP(PORIT)-NEI((IFP(PORIT)-NEI(POAP2P(1)))/24)*24
N368  IF(RICUT) RUNP2P(1)=1  [begin movment
N369  TIRIC(5)=RUNP2P(1)~TDRIC     [signal INPOS
N370  [note: entered only if MZAP2P is present
N371  IF(SGLP2P(1)&”TDRIC) RICUT=0 [movment completed
N372  RTS
N373  ZEMAG:JGPP2P(1)=RICUT  [zero search
N374  MCZP2P(1)=RICUT        [set zero search
N375  INPOS=0                      [reset position OK
N376  RTS
N377  [............ program end ............................
```

SCROLLIN - Manage upto 128 messages with on screen scrolling

```
N1      [*******************************************************
N2      [*                                                     *
N3      [*        Program for on screen message scrolling      *
N4      [*            SCROLLIN      940516                     *
N5      [*                                                     *
N6      [*******************************************************
N7      [
N8      [THIS PROGRAM DISPLAYS A MAXIMUM OF 16 CONTEMPORARY MESSAGES.
N9      [SEQUENCING ONLY THOSE DECLARED ACTIVE
N10     [(In the example NMAX=48)
N11     [To display the nth message with automatic scrolling
N12     [the corresponding nth bit of SG must be set
N13     [
N14     INP
N15     I1          [message  1 enable input
N16     I2          [message 10 enable input
N17     I3          [message 47 enable input
N18     [
N19     RAM,8
N20     NMSG        [message index
N21     NMAX        [MAX number of messages
N22     NRIGA       [message row number
N23     [Declare up to SGxx where (xx) >NMAX/8
N24     SG          [flag for messages numbered from  1 to  8
N25     SG2         [flag for messages numbered from  9 to 16
N26     SG3         [flag for messages numbered from 17 to 24
N27     SG4         [flag for messages numbered from 25 to 32
N28     SG5         [flag for messages numbered from 33 to 40
N29     SG6         [flag for messages numbered from 41 to 48
N30     [
N31     STR
N32     MSG(48)     [48-message vector
N33     [           declare NMAX elements
N34     [
N35     INIT
N36     NMAX=48     [maximum number of messages
N37     [
N38     [messages to be displayed
N39     MSG(1)= 'AXIS ALARM: CHECK SERVOAMPLIFIER FUSES'
N40     MSG(2)= 'SLIDE LUBRIFICATION MOTOR OVERLOAD'
N41     MSG(3)= 'COULANT MOTOR OVERLOAD'
N42     MSG(4)= 'SPINDLE FAN MOTOR OVERLOAD'
N43     MSG(10)='SPINDLE MOTOR OVERTEMPERATURE'
N44     MSG(17)='SERVOAMPLIFIER OVERLOAD'
N45     MSG(18)='COMPRESSED AIR FAULT'
N46     MSG(19)='AXES OUT OF TRAVEL LIMIT'
N47     MSG(47)='SPINDLE SERVOAMPLIFIER NOT READY'
N48     MSG(48)='--'
N49     [
N50     [
N51     [ ............PROGRAM.................................
N52     PROG
N53     END
N54     END
N55     [ ............very slow section.......................
N56     [ message enable
N57     SG(1)=I1
N58     SG(10)=I2
N59     SG(47)=I3
N60     [
```

```
N61     CALL SCROLL   [ call to handling message routine
N62     [
N63     END
N64     [
N65     [......... routines section.............................
N66     [ ........... ON SCREEN MESSAGE MANAGEMENT .................
N67     SCROLL:$
N68     NMSG=1; NRIGA=1                [SETUP OF VARIABLES
N69     LOOVIS: IF(NMSG > NMAX) CLRSCR [if end of scanning go to CLR
N70     IF(NRIGA>16) RTS               [exit if more than 16 messages
N71     IF(SG(NMSG)) DISPL, NRIGA, MSG(NMSG); NRIGA=NRIGA+1 [DISPL
N72     NMSG=NMSG+1; LOOVIS            [test other SG
N73     CLRSCR: IF(NRIGA>16) RTS       [any nore rows to clear ?
N74     CLR,(NRIGA); NRIGA=NRIGA+1; CLRSCR [clear subsequent rows.
N75     [ .............. program end ........................
```

SHIFTZ - EXAMPLE OF COMPENSATION FOR Y FALL AS A FUNCTION OF Z

```
N1      [*********************************************************
N2      [*  EXAMPLE OF COMPENSATION FOR Y FALL AS A FUNCTION OF Z     ]
N3      [*       ____________________                                 ]
N4      [*           SHIFTZ  940516                                   ]
N5      [*********************************************************
N6      [
N7      [Compensation of vertical Z axis as a function of
N8      [the fall or droop of the horizontal Y ram.
N9      [The compensation is executed only if the axes are interlocked
N10     [if not interlocked the compensation implies a shift in the Z
N11     [axis height. It will be executed later when the axis is enabled.
N12     [
N13     [
N14     [***************** DECLARATION SECTION ******************
N15     [   physical inputs
N16     INP
N17     [   physical output
N18     OUT
N19     UMOVE1              [enable axis 1
N20     UMOVE2              [enable axis 2
N21     UMOVE3              [enable axis 3
N22     [
N23     [   internal variables
N24     SRAM,32
N25     TABCOZ(11)              [table with values for Z compensation
N26     [
N27     RAM,32
N28     FCYP                    [Z position at positive end of Y travel
N29     FCYN                    [Z position at negative end of Y travel
N30     NCAMPY              [number of steps
N31     STEPY                   [distance between steps
N32     QUOYI                   [vert. pos. of Y referred to negative travel end
N33     COMPZ                   [current compensation value
N34     IND                 [current step number
N35     [
N36     RAM,8
N37     IND8                    [current step number in byte format
N38     [
N39     INIT
N40     FCYP=100            [position of Y+ software limit
N41     FCYN=-200               [position of Y- software limit
N42     NCAMPY=10               [number of compensation steps
N43     STEPY=(FCYP-FCYN)/NCAMPY [calculate step value
N44     [
N45     PROG
N46     [****************** FAST SECTION ************************
N47     POFO=ANI(1)         [axes feed override potentiometer
N48     [
N49     UMOVE1=MOVCN(1)  [enable axes
N50     UMOVE2=MOVCN(2)
N51     UMOVE3=MOVCN(3)
N52     RDMOV=MOVCN
N53     END
N54     [***************** SLOW SECTION *************************
N55     [..................... auxiliary functions ..................
N56     [
N57     BURDY=0             [...acquire function from NC
N58     [
N59     [............... fall compensation ......................
N60     QUOYI=POA(2)-FCYN       [vert. pos. relative to Y -ve soft limit
```

```
N61     IND=INT(QUOYI/STEPY)     [current step number
N62     IND8=FPI(IND)            [step in byte format
N63     COMPZ=((QUOYI-STEPY*IND)*(TABCOZ(IND8+2)-TABCOZ(IND8+1))/$
N64     STEPY)+TABCOZ(IND8+1)    [interpolation between steps
N65     [limit outside software end limits
N66     IF(POA(2)<=FCYN) COMPZ=TABCOZ(1)
N67     IF(POA(2)>FCYP) COMPZ=TABCOZ(FPI(NCAMPY+1))
N68     SHIFT(3)=COMPZ           [execute compensation
N69     [
N70     END
N71     [.............. program end ..............................
```

AXBLOC1 - Clamped axes with timed wait

```
N1   [*******************************************************
N2   [*    AXES WITH TIMED CLAMPING/UNCLAMPLING                          ]
N3   [*          ———————————————                                        ]
N4   [*               AXBLOC1     941010                                ]
N5   [*******************************************************
N6   [
N7   INP
N8   IMUON                  [ 1 auxiliaries on
N9   IDRAOK                      [ 2 drives OK
N10  [
N11  OUT
N12  UMOVE1                      [1  enable axis 1
N13  TERM,5
N14  USFREX                      [6  unclamp axis X
N15  [
N16  [     variabili interne
N17  RAM,8
N18  MOVCNP                      [copy of old MOVCN for variations
N19  [
N20  STIMER
N21  TISBX,TUSBX,TDSBX,TASBX,TWSBX      [unclamp axis X
N22  TIBLX,TUBLX,TDBLX,TABLX,TWBLX      [clamp axis X
N23  [
N24  PROG
N25  END
N26  [**************** SLOW SECTION *************************
N27  [.............. auxiliary functions.....................
N28  BURDY=0                [... acquire function from NC
N29  POFO=ANI(1)      [axes feed pot.
N30  [
N31  [..................... management axes.....................
N32  TISBX(3)=MOVCN(1)                          [timer unclamp
N33  TIBLX(5)=(“MOVCN(1)&MOVCNP(1))~TDBLX     [timer clamp
N34  [
N35  UMOVE1=(MOVCN(1)~TDBLX)&IMUON&IDRAOK     [enable axes
N36  USFREX=MOVCN(1)&IMUON&IDRAOK             [unclamp
N37  [
N38  RDMOV(1)=(MOVCN(1)&”TDSBX)~TDBLX         [response to NC
N39  MOVCNP=MOVCN                                    [by MOVCN derivative
N40  [
N41  REME=FF(“IMUON~”IDRAOK),(EMEA)           [emergency request
N42  END
N43  IF(RDMOV<>MOVCN) DISPL,1,’WAIT FOR AXES CLAMP/UNCLAMP’;$
N44  ELSE CLR,1
N45  IF(“IMUON) DISPL,2,’AUXILIARIES NOT ON’; ELSE CLR,2
N46  IF(“IDRAOK) DISPL,3,’FAULT IN AXES MOVEMENT’; ELSE CLR,3
N47  END
N48  [..................program end .......................
```

AXBLOC2 - Clamp axes with external enable

```
N1   [*********************************************************
N2   [*   CLAMP/UNCLAMP axes with PRESSURE SWITCH                        ]
N3   [*          ______________                                         ]
N4   [*                AXBLOC2    941010                                ]
N5   [*********************************************************
N6   [unclamping using a pressure switch
N7   [and clamping with a timed wait.
N8   [
N9   [     physical inputs
N10  [
N11  INP
N12  IMUON            [ 1 auxiliaries on
N13  IDRAOK                [ 2 drives OK
N14  ISBLOX                [ 3 X axis unclamped (pressure switch)
N15  [
N16  [     physical outputs
N17  OUT
N18  UMOVE1                [1  enable axis 1
N19  TERM,5
N20  USFREX                [6  unclamp axis X
N21  [
N22  [     internal variables
N23  RAM,8
N24  MOVCNP                [copy of old MOVCN for variations
N25  [
N26  STIMER
N27  TIBLX,TUBLX,TDBLX,TABLX,TWBLX      [clamp axis X
N28  [
N29  PROG
N30  END
N31  [***************** SLOW SECTION **************************
N32  [.................. various ....................................
N33  POFO=ANI(1)      [feed override pot.
N34  BURDY=0               [... acquire function from NC
N35  [
N36  [..................... axes management ........................
N37  TIBLX(5)=("MOVCN(1)&RDMOV(1)&"ISBLOX)    [timer clamp X
N38  [
N39  UMOVE1=(MOVCN(1)~RDMOV(1))&IMUON&IDRAOK  [enable X
N40  USFREX=MOVCN(1)&IMUON&IDRAOK             [unclamp X
N41  [
N42  RDMOV(1)=(MOVCN(1)&ISBLOX)~RDMOV(1)&"(TUBLX~EMEA)[NC response
N43  [
N44  END
N45  [***************** VERY SLOW SECTION *********************
N46  IF(RDMOV<>MOVCN) DISPL,1,'WAIT CLAMP/UNCLAMP AXES';$
N47  ELSE CLR,1
N48  IF("IMUON) DISPL,2,'AUXILIARIES NOT ON'; ELSE CLR,2
N49  IF("IDRAOK) DISPL,3,'FAULT IN AXES MOVMENT'; ELSE CLR,3
N50  END
N51  [................... program END ........................
```

ESSINCU - Synchronous tool change with grid

```
N1   [*********************************************************
N2   [*  SYNCHRONOUS TC - TOOLS IN FIXED POSITION ON A GRID
N3   [*          ESSINCU     941010                                    ]
N4   [*          ————————————————                                      ]
N5   [*                                                                ]
N6   [*********************************************************
N7   [
N8   [****** COM PROGRAMS FOR AXIS MOVEMENTS RUN BY THE PLC *****
N9   [CUAUTO:
N10  [P1=4       [number of tool in each row
N11  [P2=6       [number of tool in each column
N12  [P3=10           [tool center-to-center distance each row
N13  [P4=20           [tool center-to-center distance each column
N14  [P5=0       [X position 1^ tool
N15  [P6=0       [Y position 1^ tool
N16  [P7=150          [Z position high
N17  [P8=100          [Z position for change
N18  [
N19  [P34=1           [parameter always set to 1
N20  [[P10       [loaded from PLC: loading position
N21  [[P11       [loaded from PLC: unloading position
N22  [[P13       [loaded from PLC: sequence number
N23  [[P14,P15,P16    [loaded from PLC: temporary parameters
N24  [[P17       [X position requested tool
N25  [[P18       [Y position requested tool
N26  [————————————————————————
N27  [M62             [open door
N28  [O0              [absolute origin
N29  [test for case:
N30  [these are jumps not Calls !
N31  [{P13=6} L6 [exchange with storage
N32  [{P13=7} L7 [load tool from storage
N33  [{P13=8} L8 [unload tool into storage
N34  [{P13=4} L4 [unload spindle to floor & load from storage.
N35  [{P13=5} L5 [unload spindle to storage & load from floor
N36  [{P34=1} L34     [go to end TC (for safety only)
N37  [————————————————————————
N38  [case 6
N39  [L=6
N40  [unload: ————————————————————————
N41  [ZP7RM19    [Z safe height
N42  [P14=P11    [load position for unloading
N43  [L99        [call routine for tool X, Y
N44  [XP17YP18R  [go to unloading location
N45  [ZP8R       [Z for change
N46  [M64        [unlock tool
N47  [G4K5       [0.5 sec
N48  [ZP7R       [Z safe height
N49  [
N50  [load: ————————————————————————
N51  [P14=P10         [load position for loading
N52  [L99             [call routine for tool X, Y
N53  [XP17YP18R  [go to loading location
N54  [ZP8R       [Z for change
N55  [M65             [lock tool
N56  [G4K5       [0.5 sec
N57  [ZP7R       [Z safe height
N58  [{P34=1} L34     [go to end ————————————————————
N59  [
N60  [... other cases (L=...)
N61  [L=7
N62  [M0         [Sequence to be defined
N63  [{P34=1} L34     [go to end ————————————————————
N64  [
N65  [L=8
N66  [M0         [Sequence to be defined
N67  [{P34=1} L34     [go to end ————————————————————
N68  [
N69  [L=4
N70  [M0         [Sequence to be defined
N71  [{P34=1} L34     [go to end ————————————————————
N72  [
N73  [L=5
N74  [M0   [     Sequence to be defined
N75  [{P34=1} L34     [go to end ————————————————————
N76  [
```

```
N77   [part common to all cases:
N78   [L=34
N79   [O-1        [reset origin
N80   [M29        [activate correction
N81   [M63        [close storage door
N82   [M34        [end tool change
N83   [G32        [end program
N84   [——————— routine to calculate tool X, Y  ———————
N85   [L=99
N86   [P15=INT(P(14)/(P1+1))
N87   [P16=P10-(P1*P15)-1
N88   [P17=P5+P16*P4
N89   [P18=P6+P15*P3
N90   [G32
N91   [————————— end CUAUTO ———————————————
N92   [CUMANU:
N93   [P90=1
N94   [{P13=1}  L1      [load from floor
N95   [{P13=2}  L1      [unload to floor
N96   [{P13=3}  L1      [exchange with floor
N97   [{P13=11} L11     [Tprog. = Tspindle
N98   [{P90=1} L90
N99   [
N100  [cases 1, 2, 3
N101  [L=1
N102  [M26        [manual tool change
N103  [M29        [activate correction
N104  [{P90=1} L90
N105  [
N106  [case 11
N107  [L=11
N108  [M29        [activate correction
N109  [
N110  [L=90
N111  [M34        [end tool change
N112  [——————————————————————————
N113  [
N114  INP
N115  IAUXON            [ 1 Auxiliaries on
N116  IRIMAA            [ 2 Storage door open
N117  IRIMAC            [ 3 Storage door closed
N118  [...  [ others ...
N119  [
N120  OUT
N121  ABX         [ 1 enable axis X
N122  ABY         [ 2 enable axis Y
N123  ABZ         [ 4 enable axis Z
N124  UARIMA      [ 7 output open storage door
N125  UCRIMA      [ 8 output close storage door
N126  [...  [ others ...
N127  [
N128  RAM,1
N129  ERRM06      [M6 programmed without T
N130  [           [stored commands automatic TC
N131  MM26        [manual tool change
N132  MM62        [open storage door
N133  MM63        [close storage door
N134  [...  [others ...
N135  [
N136  STR
N137  MSG(10)           [text for messages and alarms
N138  [
N139  SOFTK,1
N140  [           '+————+————+————'
N141  P1,CUAUT,   'AUTOMATIC TC.'
N142  P2,CUMAN,   'MANUAL TC'
N143  P3,L3,            ''
N144  P4,L4,            'end manual TC'
N145  P5,L5,            ''
N146  P6,L6,            ''
N147  P7,L7,            'RESET TC'
N148  P8,L8,            ''
N149  [
N150  [
N151  INIT  [INITIALIZATION SECTION
N152  [
N153  MSG(1)= 'VERIFY TOOL TABLE AND RESET THE TC'
N154  MSG(2)= 'change tool manually'
N155  MSG(3)= 'M6 programmed without Txx'
```

```
N156  MSG(4)= ‘Wait storage open’
N157  MSG(5)=’Wait storage door closed’
N158  [
N159  [
N160  [***** DEFINITION OF TOOL CHANGE SEQUENCES ********
N161  [... TC SEQUENCE TO LOAD TOOL FROM FLOOR WITH SPINDLE EMPTY ...
N162  DEF SEQCU(1)=-6,-16,-34,COM,1,’CUMANU’
N163  [
N164  [...TC SEQUENCE TO UNLOAD SPINDLE TO FLOOR (T0M6) ...
N165  DEF SEQCU(2)=-6,-10,-34,COM,1,’CUMANU’
N166  [
N167  [...TC SEQUENCE TO EXCHANGE BETWEEN SPINDLE & FLOOR ...
N168  DEF SEQCU(3)=-6,-10,-16,-34,COM,1,’CUMANU’
N169  [
N170  [...TC SEQUENCE TO UNLOAD SPINDLE TO FLOOR & LOAD FROM STORAGE ...
N171  DEF SEQCU(4)=-6,-10,-1,-4,-34,COM,1,’CUAUTO’
N172  [
N173  [...TC SEQUENCE TO UNLOAD SPINDLE TO STORAGE & LOAD FROM FLOOR ...
N174  DEF SEQCU(5)=-6,-23,-13,-16,-34,COM,1,’CUAUTO’
N175  [
N176  [...TC SEQUENCE TO CHANGE TOOLS WITH ONE ALREADY IN SPINDLE ...
N177  DEF SEQCU(6)=-6,-23,-13,-1,-4,-34,COM,1,’CUAUTO’
N178  [
N179  [...TC SEQUENCE TO LOAD WHEN SPINDLE IS UNLOADED ...
N180  DEF SEQCU(7)=-6,-1,-4,-34,COM,1,’CUAUTO’
N181  [
N182  [...TC SEQUENCE TO UNLOAD TOOL FROM SPINDLE TO STORAGE....
N183  DEF SEQCU(8)=-6,-23,-13,-34,COM,1,’CUAUTO’
N184  [
N185  [...TC SEQUENCE TO LOAD TOOL = TOOL IN SPINDLE ...
N186  DEF SEQCU(11)=-6,-34,COM,1,’CUMANU’
N187  [
N188  [
N189  PROG  [FAST SECTION
N190  [enable axes
N191  ABX=MOVCN(1)
N192  ABY=MOVCN(2)
N193  ABZ=MOVCN(3)
N194  RDMOV=MOVCN
N195  POFO=ANI(1)      [axes feed pot.
N196  END                    [SLOW SECTION
N197  [
N198  [——————SYNCHRONOUS PART—————————
N199  [
N200  IF(“BURDY)ASINC
N201  FHOLD=1; DHOLD=1
N202  [decoding always requires T first then M
N203  IF(STROT)CALL GEFUT
N204  IF(STROM)CALL GEFUM
N205  BURDY=0
N206  ASINC:$
N207  [—————ASYNCHRONOUS PART——————————
N208  [*****************************************************
N209  [     AUTOMATIC TC MODULE    *
N210  [*****************************************************
N211  CALL CUAUTO      [automatic TC routine
N212  [
N213  [.......... physical actuations for tool change ...........
N214  [mechanical safety locks etc. must always be put directly
N215  [in the control outputs, for example:
N216  [out  =((select_auto) ~ (select_man))    & mech_safety.
N217  [
N218  UARIMA=MM62            [&... safety
N219  UCRIMA=MM63            [&... safety
N220  [...
N221  L4=MM26                [manual TC in progress
N222  [...
N223  [
N224  [reset memories at end of operation (instructions completed)
N225  IF(IRIMAA&”IRIMAC) MM62=0          [door open
N226  IF(IRIMAC&”IRIMAA) MM63=0          [door closed
N227  IF(P4)  MM26=0               [ok end manual TC
N228  [*****************************************************
N229  [     OTHER ASYNCHRONOUS COMMANDS  *
N230  [*****************************************************
N231  [
N232  [...
N233  [...
N234  [
```

```
N235  [*****************************************************
N236  [     ALARMS,CONSENTS AND SAFETY   *
N237  [*****************************************************
N238  [related to NC
N239  DHOLD=EMACU~MM26~MM62~MM63   [ ~...
N240  FHOLD=DHOLD                        [ ~...
N241  REME=FF(“IAUXON),(EMEA) [ ~...     [emergency to NC
N242  [
N243  END
N244  [————————— VERY SLOW SECTION ————————
N245  [.............. display messages .................
N246  IF(EMACU)  DISPL,1,MSG(1); ELSE CLR,1    [TC in emergency
N247  IF(MM26) DISPL,2,MSG(2); ELSE CLR,2      [manual TC
N248  IF(ERRM06) DISPL,3,MSG(3); ELSE CLR,3    [M6 without T ready
N249  IF(MM62) DISPL,4,MSG(4); ELSE CLR,4      [wait door open
N250  IF(MM63) DISPL,5,MSG(5); ELSE CLR,5      [wait door closede
N251  [
N252  END
N253  [
N254  [————————— ROUTINES SECTION —————————
N255  [
N256  [*****************************************************
N257  [     T FUNCTION  *
N258  [*****************************************************
N259  GEFUT:$
N260  [.............. CALL FOR TOOL CHANGE ...........
N261  UTECU=TOOL  [inform TC module of required tool
N262  NEWCU=1           [request activation of TC module
N263  RTS
N264  [
N265  [*****************************************************
N266  [     M FUNCTION  *
N267  [*****************************************************
N268  GEFUM:$
N269  WNDINT(1)=AUXM
N270  IF(AUXM=6)  M06
N271  IF(AUXM=30) CALL RESET; RTS
N272  IF(“CUATT) RTS
N273  IF(AUXM=62) MM62=1; RTS
N274  IF(AUXM=63) MM63=1; RTS
N275  IF(AUXM=29) INTOF=1; RTS
N276  IF(AUXM=34) CUATT=0; RTS
N277  RTS
N278  [
N279  M06:$
N280  IF(“CUATT) ERRM06=1; RTS     [M6 without T
N281  M6PGM=1
N282  RTS
N283  [
N284  [*****************************************************
N285  [     AUTOMATIC TOOL CHANGE  *
N286  [*****************************************************
N287  [.................. selection of TC mode...................
N288  CUAUTO:$
N289  IF(CUATT) NOSELE
N290  IF(P1) SELECU=0  [automatic TC (default)
N291  IF(P2) SELECU=1  [manual TC (no storage)
N292  NOSELE:$
N293  [
N294  [mode selection softkey lights
N295  CUAUT=(SELECU=0)
N296  CUMAN=(SELECU=1)
N297  [
N298  [*****************************************************
N299  [... interruption sequence, cancellation, emergency ....
N300  [
N301  [The TC is interrupted only if:
N302  [- the auxiliaries are turned off during a TC
N303  [- a BREAK is sent during the TC sequence
N304  [
N305  [The interrupt uses REMCU and the TC responds by
N306  [setting EMACU
N307  REMCU=FF((BRKA&CUATT)~(“IAUXON&CUATT)),(EMACU)
N308  [
N309  [Softkey P7 uses RBKCU to exit from EMACU (emergency)
N310  IF(P7&EMACU) RBKCU=1   [cancel TC emergency
N311  [
N312  [After an interrupt it is necessary to reset the TC
N313  [with the appropriate softkey after VERIFYING THE TOOL TABLE
```

```
N314  L7=EMACU                    [emergency lamp TC
N315  [
N316  IF(EMACU) CALL RESECU  [reset PLC commands
N317  [
N318  [*****************************************************
N319  [Passing parameters to COM
N320  P(10)=IFP(PPRECU)      [loading position
N321  P(11)=IFP(PPOSCU)      [unloading position
N322  P(13)=IFP(NSEQCU)      [sequence started
N323  [
N324  [...... sequence decode phase ......
N325  IF (“BRDYCU) NOCU
N326  MAPRCU=0               [halt phase sequence
N327  CALL OPER              [tool change management phase
N328  BRDYCU=0               [TC phase acquired
N329  NOCU:$
N330  [
N331  [*****************************************************
N332  [............ ok to continue phase sequence .................
N333  MAPRCU=1    [&”... &”...
N334  [
N335  RTS
N336  [************ RETURN FROM CUAUTO **************
N337  [
N338  [*****************************************************
N339  [     ROUTINE TO DECODE TC and RESET OPERATIONS            *
N340  [*****************************************************
N341  [case for TC reset
N342  RESECU:$
N343  MM26=0                     [reset manual TC
N344  MM62=0
N345  MM63=0
N346  [
N347  [mormal reset (M30 or BREAK)
N348  RESET:$
N349  WNDINT(1)=30           [display M30
N350  ERRM06=0               [cancel error on M6 (M6 without T ready)
N351  RTS
N352  [————————————————————
N353  [manage TC OPERATIONS
N354  OPER:$
N355  [IF(OPERCU=...) OPCUX
N356  [...
N357  RTS
N358  [
N359  [OPCUX: ...; RTS
N360  [
N361  [............ program end ............................
```

AXP2P - Control of tool storage axis from PLC

```
N1    [*********************************************************
N2    [*POSITIONING OF TOOL STORAGE axis as an INDEPENDANT axis            ]
N3    [*          ____________________                                    ]
N4    [*                AXP2P      941008                                ]
N5    [*********************************************************
N6    [
N7    [***************** DECLARATION SECTION ********************
N8    [Consider a tool storage with 24 positions.
N9    [The algorithm will use the shortest path to the tool.
N10   [Using a non absolute transducer.
N11   [In manual mode positioning will always end over a station
N12   [
N13   [The INPOS signal indicates the last position reached.
N14   [
N15   INP
N16   IZERM       [storage zero switch
N17   IRIPM       [storage door switch
N18   [
N19   OUT
N20   UMOVEX            [enable axis X
N21   UMOVEY            [enable axis Y
N22   UMOVEZ            [enable axis Z
N23   UABMAG            [enable storage
N24   INPOS       [axis in position
N25   [
N26   RAM,16
N27   PORIT       [request positioning storage
N28   [
N29   RAM,1
N30   RICUT       [request tool storage positioning
N31   [
N32   STIMER
N33   [timer for storage positioning tolerance
N34   TIRIC,TURIC,TDRIC,TARIC,TCRIC
N35   [     softkey menu controlled by PLC
N36   SOFTK,1
N37   P1,L1,1,'  JOG + storage'
N38   P2,L2,1,'  JOG -  storage'
N39   [
N40   PROG
N41   END
N42   [***************** SLOW SECTION ***************************
N43   [ .......... decode auxiliary functions ..........
N44   IF("BURDY)ASINC
N45   DHOLD=1; FHOLD=1
N46   IF(STROT) CALL GEFUT
N47   IF(STROM) CALL GEFUM
N48   BURDY=0
N49   ASINC:$
N50   [
N51   [_____ ASYNCHRONOUS PART _____________
N52   UMOVEX=MOVCN(1)   [enable X
N53   UMOVEY=MOVCN(2)   [enable Y
N54   UMOVEZ=MOVCN(3)   [enable Z
N55   RDMOV=MOVCN       [axes enabled by NC request
N56   [
N57   [ ............... positioning storage ...................
N58   IF (NCMD<>5) NOJOG
N59   IF (P1) PORIT=FPI(NEI(POAP2P)+1); RICUT=1; L1=1
N60   IF (P2) PORIT=FPI(NEI(POAP2P)-1); RICUT=1; L2=1
N61   NOJOG:$
N62   IF("RICUT) L1=0; L2=0
N63   CALL POSMAG
N64   [
N65   [.....................general.............................
N66   FHOLD=RICUT
N67   DHOLD=RICUT       [halt data blocks
N68   REME=FF(EMAP2P(1)),(EMEA)  [machine emergency (axis)
N69   [
N70   IF(BRKA) CALL RESET    [reset PLC functions from NC
N71   [
N72   END
N73   [............... very slow section ........................
N74   WINDOW=NEI(POAP2P(1))  [display current position
N75   ASCW=109
N76   END
```

```
N77   [
N78   [********************* ROUTINES SECTION ***************
N79   [*****************************************************
N80   [     STORAGE POSITIONING: INDEPENDANT axis               *
N81   [*****************************************************
N82   POSMAG:$
N83   POTP2P(1)=1       [speed CONTROL POT.
N84   SSAP2P(1)=1       [storage always active
N85   MIZP2P(1)=IZERM   [storage zero switch
N86   UABMAG=MOVP2P(1)  [enable storage axis
N87   RDMP2P(1)=MOVP2P(1)     [axis enabled response
N88   INPOS=SGLP2P(1)&MZAP2P(1)&"RUNP2P(1)&"RICUT&"EMAP2P(1) [in pos.
N89   [
N90   [faults and reset ...
N91   IF(EMAP2P(1)) RICUT=0; RTS   [fault reset command
N92   [activate REME on EMAP2P
N93   [
N94   [if axis at zero ...
N95   IF("MZAP2P(1)) ZEMAG         [test axis zero
N96   JGPP2P(1)=0                  [cancel JOG
N97   MCZP2P(1)=0                  [cancel zero search mode
N98   [
N99   [calculate position using shortest path
N100  PFNP2P(1)=IFP(PORIT)-NEI((IFP(PORIT)-NEI(POAP2P(1)))/24)*24
N101  IF(RICUT) RUNP2P(1)=1        [start positioning
N102  TIRIC(5)=RUNP2P(1)~TDRIC     [sync signal for INPOS
N103  [note: entered only if MZAP2P is present
N104  IF (SGLP2P(1)&"TDRIC) RICUT=0  [movement completed
N105  RTS
N106  [
N107  [axis to be zeroed ...
N108  ZEMAG: $
N109  JGPP2P(1)=RICUT  [force JOG+ for zero search
N110  MCZP2P(1)=RICUT  [select search mode
N111  INPOS=0                [immediately remove INPOS
N112  RTS
N113  [
N114  [ ........ decode M & T functions ......................
N115  GEFUT:$
N116  PORIT = TOOL           [select position to search
N117  RTS
N118  [
N119  GEFUM:$
N120  WNDINT(1)=AUXM   [display M
N121  IF (AUXM=6) RICUT=1; RTS     [storage position on last T
N122  RTS
N123  [
N124  [............ reset routine.............................
N125  RESET:$
N126  IF(EMAP2P(1)) RBKP2P(1)=1; RICUT=0      [recover P2P emergency
N127  WNDINT(1)=30                      [display M30
N128  RTS
N129  [........... program end..............................
```

COMMUCM - Switch spindle with C axis

```
N1   [************************************************
N2   [*                                              ]
N3   [*         SWITCHING C axis C and SPINDLE
N4   [*          ———————————————
N5   [*          COMMUCM     940516
N6   [*
N7   [************************************************
N8   [In the configuration data the C axis is considered # 4.
N9   [Switching with the spindle (1) is accomplished via:-
N10  [M21 from spindle to C axis
N11  [M20 from C axis to spindle
N12  [It is important to use the M function at the end of
N13  [the block so that the change over cannot take place
N14  [while the axis is in motion.
N15  [The C axis and the spindle have the same I/O channels
N16  [the transducer is an encoder and in this example there
N17  [are no provisions for a home switch on the C axis.
N18  [
N19  [physical INPUTS
N20  INP
N21  [
N22  [physical OUTPUTS
N23  OUT
N24  ABILX       [ 1  enable axis X
N25  ABILY       [ 2  enable axis Y
N26  ABILM       [ 3  enable spindle or axis C
N27  ABILZ       [ 4  enable axis Z
N28  [
N29  [declare retained BIT variables (present at power up)
N30  SRAM,1
N31  CICM20           [Switch from C axis to spindle
N32  CICM21           [Switch from spindle to C axis
N33  axisC       [Set working mode for C axis
N34  axisM       [Set working mode for spindle
N35  [
N36  [declare non retained BIT variables
N37  RAM,1
N38  ABMAN [enable spindle
N39  ABC         [enable C axis
N40  [
N41  STR
N42  MSG1        [messages
N43  MSG2        [messages
N44  [
N45  [************ INITIALIZATION ********************
N46  INIT
N47  MSG1='switching from C axis C to spindle'
N48  MSG2='switching from spindle to C axis'
N49  [
N50  [******** INITIALIZE SPINDLE MODE ***************
N51  [
N52  IF ("axisC&"axisM) CALL RESCM      [if no mode
N53  IF (CICM20~CICM21) CALL RESCM      [if interrupt
N54  [
N55  SPGAM(1)=1       [range 1 for spindle
N56  [
N57  [************ FAST LOGIC (each 10 mS) **********
N58  PROG
N59  ABILX = RDMOV(1)
N60  ABILY = RDMOV(2)
N61  ABILZ = RDMOV(3)
N62  RDMOV = MOVCN     [Move as a response to NC
N63  [
N64  [****** potentiometers ********************
N65  POFO=ANI(1)
N66  POMO(1)=ANI(2); POMO(2)=ANI(2); POMO(3)=ANI(2)
N67  END
N68  [***** decode auxiliary functions from NC ******
N69  IF ("BURDY) ASINC
N70  DHOLD=1; FHOLD=1
N71  IF (STROM) CALL GEFUM
N72  BURDY=0
N73  ASINC: $
N74  [
N75  IF(BRKA) CALL LM05           [stop spindle on BREAK
N76  [
```

```
N77   [*************** MANAGE C axis ****************
N78   [reset sequence (interrupt)
N79   IF(BRKA&(CICM20~CICM21)) CALL RESCM
N80   [
N81   [manage potentiometers
N82   IF(CICM21) POMO(4)=.1; ELSE POMO(4)=ANI(2)
N83   [
N84   [........ switch from C axis to spindle .................
N85   [sequence: - DISRQ(4)=1
N86   [            - SPDRQ(1)=0 e SPDIS(1)=0
N87   [            - axisC=0; axisM=1
N88   IF(“CICM20) NOCM
N89   IF(“SPDRQ(1)) axisC=0; axisM=1; CICM20=0; NOCM
N90   IF(DISRQ(4)) SPDRQ(1)=0; SPDIS(1)=0; NOCM
N91   DISRQ(4)=1; SSA(4)=0
N92   NOCM: $
N93   [
N94   [.............. switch from spindle to C axis ............
N95   [sequence:  - wait “SPMOT(1)
N96   [           - SPDRQ(1)=1; SPDIS(1)=1
N97   [           - DISRQ(4)=0
N98   [           - FOMAN(4)=1; MARK(4)=1; JOGP(4)=1
N99   [           - attesa MIZEA(4)
N100  [           - JOGP(4)=0; MARK(4)=0; FOMAN(4)=0
N101  [           - attesa “JOGIN(4)
N102  [           - SSA(4) = 1 (if necessary)
N103  [           - axisC=1; axisM=0
N104  IF(“CICM21) NOMC
N105  IF(SSA(4)&MIZEA(4)) axisC=1; axisM=0; CICM21=0;NOMC       [end cycle
N106  IF(MIZEA(4)&”JOGIN(4)) SSA(4)=1; NOMC               [SSA
N107  IF(MIZEA(4)) FOMAN(4)=0;MARK(4)=0;JOGP(4)=0; NOMC   [zero done
N108  [do zero
N109  IF(“MIZEA(4)&”DISRQ(4)) FOMAN(4)=1; MARK(4)=1; JOGP(4)=1; NOMC
N110  IF(SPDRQ(1)) DISRQ(4)=0; NOMC
N111  IF(“SPMOT(1)) SPDRQ(1)=1; SPDIS(1)=1
N112  NOMC: $
N113  [
N114  [..............spindle management ........................
N115  [
N116  [speed and override potentiometer
N117  SPSSO(1)=ANI(3)
N118  SPVEL(1)=SPEED
N119  [
N120  ABMAN=SPMOV(1)                    [store SPINDLE enabling
N121  ABC=MOVCN(4)                      [store C axis enabling
N122  ABILM=ABMAN~ABC              [
N123  [
N124  [******* MANAGE ENABLES TO NC  *******
N125  DHOLD = CICM20~CICM21
N126  FHOLD = DHOLD
N127  [
N128  END
N129  GIRMI=INT(ABS(SPTCH))  [display effective speed
N130  WINDOW=PASP            [display spindle position
N131  ASCW=109
N132  IF(axisC) DISPL,0,’C axis ACTIVE’; ELSE CLR,0
N133  END
N134  [
N135  GEFUM:$
N136  IF ((AUXM = 3)&axisM) SPROT(1)=1; SPDIR(1)=0; RTS
N137  IF ((AUXM = 4)&axisM) SPROT(1)=1; SPDIR(1)=1; RTS
N138  IF (AUXM =  5) LM05
N139  IF (AUXM = 20) LM20
N140  IF (AUXM = 21) LM21
N141  RTS [Programmed function (Not controlled)
N142  [
N143  LM05: SPROT(1)=0; RTS
N144  LM20: IF(axisC) CICM20=1; RTS; ELSE RTS [from C to S
N145  LM21: IF(axisM) CALL LM05; CICM21=1; RTS; ELSE RTS [from S to C
N146  [
N147  [Reset to SPINDLE on interruption
N148  RESCM: $
N149  JOGP(4)=0; MARK(4)=0; FOMAN(4)=0; DISRQ(4)=1
N150  SPDRQ(1)=0; SPDIS(1)=0
N151  CICM20=0; CICM21=0
N152  axisC=0; axisM=1
N153  RTS
N154  [................... program end .......................
```

NEWFILT - Numerical Filter

```
N1    [************************************************
N2    [*  NUMERICAL FILTER (ANALOG INPUT)
N3    [*         940930           NEWFILT
N4    [************************************************
N5    INP
N6    OUT
N7    [
N8    RAM,32
N9    SOMMA       [sum of last readings
N10   ELE(30)           [table of last readings
N11   MEDIA       [filtered result
N12   [
N13   RAM,8
N14   MAXELE            [maximum number of readings
N15   IELE              [index of current element
N16   [
N17   INIT
N18   MAXELE=30   [number of reads per sample
N19   [
N20   PROG
N21   IELE=IELE+1                  [current element
N22   IF(IELE>MAXELE) IELE=1       [check on maximum number
N23   SOMMA=SOMMA-ELE(IELE)        [remove old element from sum
N24   ELE(IELE)=ANI(1)             [read new element
N25   SOMMA=SOMMA+ELE(IELE)        [put new element in place
N26   MEDIA=SOMMA/IFP(MAXELE)      [divide sum by number of reads
N27   END
N28   [.................. program end ........................
```

TABUTE1 - Reorder tool positions in table

```
N1    [************************************************
N2    [           RECONFIGURE TOOL TABLE
N3    [           TABUTE1          940908
N4    [************************************************
N5    [
N6    RAM,16
N7    IND               [Index of current element
N8    [
N9    RAM,1
N10   MM1234            [Reset cycle in progress
N11   [
N12   PROG
N13   END
N14   [
N15   IF(“BURDY) ASINC
N16   DHOLD=1; FHOLD=1
N17   IF(STROM&(AUXM=1234)) CALL GEFUM
N18   BURDY=0
N19   ASINC:$
N20   [
N21   DHOLD=MM1234
N22   FHOLD=DHOLD
N23   [
N24   [.............. RESET TOOL TABLE .............
N25   [This cycle repositions the tool places
N26   [from 1 to the number of storage places.
N27   IF(“MM1234) SKIP        [cycle M1234 not active
N28   IF(UTEFRE<=0) SKIP      [no more entries possible
N29   EXEC=UTEFRE             [write the required number of entries
N30   IF(IND>MAGNPO) MM1234=0;NOWRI      [Cycle finished
N31   UTPOS(IND)=IND          [Load position
N32   IND=IND+1               [Increment position index
N33   NOWRI:$
N34   ENDE
N35   SKIP:$
N36   [
N37   END
N38   END
N39   [
N40   GEFUM:$
N41   MM1234=1               [Start cycle
N42   IND=1             [Initialize index
N43   RTS
```

TESTAR - Indexed head moved by spindle motor

```
N1   [*******************************************************
N2   [                                                                ]
N3   [     EXAMPLE: SWITCHING SPINDLE WITH INDEXED HEAD (A axis)
N4   [                                                                ]
N5   [                TESTAR  941010
N6   [*******************************************************
N7   [This example shows the switching technique to control
N8   [spindle and head with the same motor and transducer.
N9   [configuration parameters are defined in two channels
N10  [that the PLC program will enable alternately.
N11  [
N12  [The preffered method is to use two sequences controlled
N13  [by the PLC using the functions M20 and M21 to simplify
N14  [the use of other comands necessary for the mechanical
N15  [operations and the extension to two axes.
N16  [
N17  [The head axis uses the spindle transducer in incremental
N18  [mode, so to avoid a reset occuring when the marker pulse
N19  [is sensed the axis must be configured for a home switch.
N20  [
N21  [On power up a two phase initialization is carried out:
N22  [1-update head position
N23  [2-switch to spindle
N24  [
N25  [program PROM21 switches the spindle to the head axis
N26  [————————————————————
N27  [M5              [stop spindle (orient if requested)
N28  [M101      [disable reading and control of spindle
N29  [M102      [start reading head axis
N30  [M103      [update current head position
N31  [M104      [enable control of head axis
N32  [
N33  [program PROM20 switches head axis to spindle
N34  [————————————————————
N35  [M112      [disable reading and control of head
N36  [M113      [enable reading and control of spindle
N37  [*******************************************************
N38  [
N39  INP
N40  OUT
N41  TERM,3
N42  ABM         [enable spindle operation
N43  [
N44  SRAM,32
N45  MEMTA       [store head A
N46  RAM,1
N47  ROTMA       [rotation command
N48  [
N49  PULSE
N50  PFASE2           [pulse 2a initialization phase
N51  INIT
N52  SPGAM(1)=1  [range 1 (only)
N53  [
N54  CALL INTSTA [initialize head
N55  [
N56  PROG
N57  END
N58  IF(PFASE2) CALL FASE2
N59  IF(“BURDY) ASINC
N60  IF(STROM) CALL GEFUM
N61  BURDY=0
N62  ASINC:$
N63  [
N64  [*************** control head axis (A) *********************
N65  [
N66  RDMOV(4)=MOVCN(4)
N67  IF(MOVCN(4)&RDMOV(4)) MEMTA=POO(4)
N68  POFO=ANI(1)
N69  [***************  spindle ************************
N70  SPVEL(1)=SPEED
N71  SPSSO(1)=0.7 + ANI(3)*0.6
N72  SPROT(1)=ROTMA&”HOLDA        [rotation and HOLD commands
N73  ABM=SPMOV(1)~RDMOV(4)[&...   [enable + consents
N74  [
N75  END
N76  [ ............... very slow section .......................
```

```
N77   GIRMI=INT(ABS(SPTCH))        [display S
N78   END
N79   [
N80   [— ROUTINES ————————————————————
N81   GEFUM: $
N82   WNDINT(1)=AUXM               [display M
N83   IF(AUXM=3) M03
N84   IF(AUXM=4) M04
N85   IF(AUXM=5) M05
N86   IF(AUXM=20) M20
N87   IF(AUXM=21) M21
N88   IF(AUXM=101) M101
N89   IF(AUXM=102) M102
N90   IF(AUXM=103) M103
N91   IF(AUXM=104) M104
N92   IF(AUXM=112) M112
N93   IF(AUXM=113) M113
N94   RTS
N95   M03: SPDIR(1)=0; ROTMA=1; RTS
N96   M04: SPDIR(1)=1; ROTMA=1; RTS
N97   M05: ROTMA=0; RTS
N98   M20:COM,1,'PROM20';RTS
N99   M21:COM,1,'PROM21';RTS
N100  M101:SPDRQ(1)=1;SPDIS(1)=1;RTS     [disable reading and
N101  [                                       [spindle control
N102  M102:DISRQ(4)=0;RTS                     [enable head axis reads
N103  [
N104  M103:SHIFT(4)=SHIFT(4)+POO(4)-MEMTA;RTS  [update head
N105  [
N106  M104:DSERV(4)=0;RTS                     [enable head axis control
N107  [
N108  M112:DISRQ(4)=1;DSERV(4)=1;RTS     [disable reading and
N109  [                                       [head control
N110  M113:SPDRQ(1)=0;SPDIS(1)=0;RTS     [enable reading and
N111  [                                       [spindle control
N112  [
N113  INTSTA:SPDRQ(1)=1                 [phase 1 initialize head
N114  SPDIS(1)=1
N115  DSERV(4)=1
N116  DISRQ(4)=0
N117  SHIFT(4)=SHIFT(4)+POO(4)-MEMTA
N118  PFASE2=1                        [set pulse 2a init. phase
N119  RTS
N120  [
N121  FASE2:ROTMA=0                  [phase 2 head init.
N122  SPDIS(1)=0
N123  SPDRQ(1)=0
N124  DISRQ(4)=1
N125  DSERV(4)=1
N126  RTS
N127  [.................. program end.............................
```

APPENDICES

APPENDIX A - ASCII CODE TABLE

DEC	HEX	CHAR
000	00	(NULL)
001	01	(SOH)
002	02	(STX)
003	03	(ETX)
004	04	(EOT)
005	05	(ENQ)
006	06	(ACK)
007	07	(BEL)
008	08	(BS)
009	09	(HT)
010	0A	(LF)
011	0B	(VT)
012	0C	(FF)
013	0D	(CR)
014	0E	(SO)
015	0F	(SI)

DEC	HEX	CHAR
016	10	(DLE)
017	11	(DC1)
018	12	(DC2)
019	13	(DC3)
020	14	¶ (DC4)
021	15	§ (NACK)
022	16	(SYN)
023	17	(ETB)
024	18	(CAN)
025	19	(EM)
026	1A	(SUB)
027	1B	(ESC)
028	1C	(FS)
029	1D	(GS)
030	1E	(RS)
031	1F	(US)

DEC	HEX	CHAR
032	20	BLANK
033	21	!
034	22	"
035	23	#
036	24	$
037	25	%
038	26	&
039	27	'
040	28	(
041	29	)
042	2A	*
043	2B	+
044	2C	,
045	2D	-
046	2E	.
047	2F	/

DEC	HEX	CHAR
048	30	0
049	31	1
050	32	2
051	33	3
052	34	4
053	35	5
054	36	6
055	37	7
056	38	8
057	39	9
058	3A	:
059	3B	;
060	3C	<
061	3D	=
062	3E	>
063	3F	?

DEC	HEX	CHAR
064	40	@
065	41	A
066	42	B
067	43	C
068	44	D
069	45	E
070	46	F
071	47	G
072	48	H
073	49	I
074	4A	J
075	4B	K
076	4C	L
077	4D	M
078	4E	N
079	4F	O

DEC	HEX	CHAR
080	50	P
081	51	Q
082	52	R
083	53	S
084	54	T
085	55	U
086	56	V
087	57	W
088	58	X
089	59	Y
090	5A	Z
091	5B	[
092	5C	\
093	5D	]
094	5E	^
095	5F	_

DEC	HEX	CHAR
096	60	`
097	61	a
098	62	b
099	63	c
100	64	d
101	65	e
102	66	f
103	67	g
104	68	h
105	69	i
106	6A	j
107	6B	k
108	6C	l
109	6D	m
110	6E	n
111	6F	o

DEC	HEX	CHAR
112	70	p
113	71	q
114	72	r
115	73	s
116	74	t
117	75	u
118	76	v
119	77	w
120	78	x
121	79	y
122	7A	z
123	7B	{
124	7C	|
125	7D	}
126	7E	~
127	7F	Δ

DEC	HEX	CHAR
128	80	Ç
129	81	ü
130	82	é
131	83	â
132	84	ä
133	85	à
134	86	å
135	87	ç
136	88	ê
137	89	ë
138	8A	è
139	8B	ï
140	8C	î
141	8D	ì
142	8E	Ä
143	8F	Å

DEC	HEX	CHAR
144	90	É
145	91	æ
146	92	Æ
147	93	ô
148	94	ö
149	95	ò
150	96	û
151	97	ù
152	98	ÿ
153	99	Ö
154	9A	Ü
155	9B	¢
156	9C	£
157	9D	¥
158	9E	Pt
159	9F	f

DEC	HEX	CHAR
160	A0	á
161	A1	í
162	A2	ó
163	A3	ú
164	A4	ñ
165	A5	Ñ
166	A6	ª
167	A7	º
168	A8	¿
169	A9	⌐
170	AA	¬
171	AB	½
172	AC	¼
173	AD	¡
174	AE	«
175	AF	»

DEC	HEX	CHAR
176	B0	▒
177	B1	▓
178	B2	▒
179	B3	│
180	B4	┤
181	B5	╡
182	B6	╢
183	B7	╖
184	B8	╕
185	B9	╣
186	BA	║
187	BB	╗
188	BC	╝
189	BD	╜
190	BE	╛
191	BF	┐

DEC	HEX	CHAR
192	C0	└
193	C1	┴
194	C2	┬
195	C3	├
196	C4	─
197	C5	┼
198	C6	╞
199	C7	╟
200	C8	╚
201	C9	╔
202	CA	╩
203	CB	╦
204	CC	╠
205	CD	═
206	CE	╬
207	CF	╧

DEC	HEX	CHAR
208	D0	╨
209	D1	╤
210	D2	╥
211	D3	╙
212	D4	╘
213	D5	╒
214	D6	╓
215	D7	╫
216	D8	╪
217	D9	┘
218	DA	┌
219	DB	█
220	DC	▄
221	DD	▌
222	DE	▐
223	DF	▀

DEC	HEX	CHAR
224	E0	α
225	E1	β
226	E2	Γ
227	E3	π
228	E4	Σ
229	E5	σ
230	E6	µ
231	E7	τ
232	E8	ϕ
233	E9	θ
234	EA	Ω
235	EB	δ
236	EC	∞
237	ED	∅
238	EE	∈
239	EF	∩

DEC	HEX	CHAR
240	F0	≡
241	F1	±
242	F2	≥
243	F3	≤
244	F4	⌠
245	F5	⌡
246	F6	÷
247	F7	≈
248	F8	°
249	F9	●
250	FA	•
251	FB	√
252	FC	n
253	FD	2
254	FE	■
255	FF	BLANK "FF"

APPENDIX B - AUXILIARY FUNCTION TABLE

This table contains the principle auxiliary functions defined in the ISO RS-274 D standard.

CODE	ACTIVE FIRST IN BLOCK	ACTIVE LAST IN BLOCK	HANDLED BY NC	FUNCTION DESCRIPTION
M00 - M01 - M02		X	X	Stop program
M03	X			Spindle ON CW
M04	X			Spindle ON CCW
M05		X		Spindle stop
M06		X		Tool change
M07 - M08	X			Coolant ON
M09		X		Coolant OFF
M10	X			Clamp axes
M11	X			Unclamp axes
M12		X		Syncronization
M13	X			Spindle ON CW with coolant
M14	X			Spindle ON CCW with coolant
M15 - M18	X			Unassigned
M19		X		Spindle orient
M20 - M29		X		Unassigned
M30		X	X	End of program
M31 - M39	X			Unassigned
M40 - M44	X			Change gear range
M45	X			Restore disabled axes
M46	X			Disable axes
M47	X			Unassigned
M48	X			Inibit rapid override
M49	X			Enable rapid override (default)
M50 - M8999	X			Unassigned
M9000 - M9999		X		Unassigned
H0 - H9999	X			Unassigned
T0 - T9999	X		X	Tool length compensation
SO - S99999	X		X	Spindle speed

APPENDIX C - NEW SERIES S3000 FUNCTIONS COMPARED TO THE S1200 SYSTEM

With respect to the S1200, the S3000 Series systems have retained the same program structure and basic instruction syntax, while broadening its usability for those cases in which the previous structure presented some limitations.

This appendix introduces the most important services;the details of the functions listed below are found in this manual. Please refer to the specific sections in the manual for further information.

C1.1. SYSTEM MANAGEMENT

- Variables have been added to allow more flexible control of the active axes (M10-M11) configuration, for clamping or for switching with other axes.
- During the execution of a program it is possible to use manual mode to move the axes that are not controlled by the part program itself.
- It is possible to home the axes without any intervention by the operator, repeating it when necessary in automatic mode.
- The velocity of the axes in JOG can be set individually for each axis.
- Indexed, gantry, or mirrored axes are easily managed.
- The PLC functions make control via a remote console possible.
- When in HOLD status during the execution of a program it is possible to move the axes in JOG or with the handwheel.
- Up to 4 spindles are now managed directly with a reduced set of instructions using the internal SPINDLE MODULE. These instructions control velocity, orientation, range change, hunt, acceleration/deceleration ramps and synchronizing with secondary spindles.
- INDEPENDENT AXES not interpolated with the primaries may be controlled using a reduced set of dedicated functions via the INDEPENDENT AXIS MOVEMENT MODULE.

- The execution of any NC program can be controlled by the PLC.
- The management of the manual or automatic tool change with subdivided tools for families or for different cuts is simplified using the TOOL CHANGE MODULE.
- Two logic sections have been introduced, in addition to the existing ones:
  Ultra FAST logic with scanning time equal to the system sampling rate(configurable).
  Ultra SLOW logic for the management of slow phenomena or very low priority functions.
- Softkeys managed by the PLC are now always present and accessible in every environment.
- Softkey selection menu to be activated can be done through an added PLC variable.
- The commands from the SOFTKEYS can be pulse or continuous for the length of time the softkey is pressed. This allows the substitution of actual external push buttons (JOG functions for example).
- Using the softkeys and the associated microeditor it is now possible to insert or to modify at the end user level the content of alphanumeric variables, as well as numeric variables.
- Servo parameters can be adjusted in real time via a softkey menu with simultaneous recall to the graphic analyzer. The results can be verified immediately without initializing the NC.

C1.2. PROGRAM DEBUGGING AND SYSTEM VERIFICATION

- Program compiling has been greatly speeded up.
- Program edit functions have been broadened with the addition of block management, as well as with the search and substitution of character sequences.
- Significant upgrades have been made to the graphic analyzer as well as the dynamic display.
- Using the tables it is possible to store all the variables and the parameters for display (dynamic or with graphic analyzer). This provides a useful analytical tool.
- The graphic analyzer and the dynamic display can be accessed quickly with simple key stroke combinations (hot keys) as an alternative to the regular menu softkeys.
- The variables are made available for the dynamic analysis of the servo axes and copying.
- The PLC can read system date and time.
- NC error signals are available to the PLC.

C1.3. PLC PROGRAMMING

- In order to augment the precision of mathematical calculations floating point double precision 64 BIT variables have been introduced.
- All the NC variables related to the axes and to the analog I/O that are made available to the PLC are in DOUBLE (RAM, 64) format. They do not require transformation operations in order to be read.
- In numeric expressions it is now possible to perform transformation nesting functions between different formats and complex mathematical operations.
- The **EQU** declaration of equivalence has been enhanced.
- Nesting of calls to subroutines is now possible.
- A repeat subroutine from more program sections is now possible.
- The **IF** instruction has been enhanced with the **ELSE** extension option more instructions linked to actual test results.
- The **EXEC** instruction can be performed in loop for a parametrial number of times.
- **DISPL** and **CLR** instructions act on a number of parametrial lines.
- The operator // directly returns the division remainder.
- The **SGN** (parameter) function returns the argument sign.
- Numerous functions have been introduced for the management of character strings with a maximum length of 254 characters.
- The implementation of sequences is simplified by previously defined provided structures (**GOTC**).
- **RAM** variables which were not retained in the S1200 upon NC shutdown are now retained in **SRAM**.

APPENDIX D –DIAGNOSTIC MESSAGES

E18: tool number different from spindle T
E19: correction value too high (> 2 mm)
E20: origin or tool number not envisaged
E21: no increment (function I)
E22: change of plane followed by incompatible functions
E23: paraxial corrections applied to polar positions
E24: function O incompatible with S1200 type tool change
E25: G duplicated
E26: position duplicated
E27: L duplicated
E28: P duplicated
E29: R duplicated
E30: S duplicated
E31: F duplicated
E32: M duplicated
E33: feature not present
E34: min. distance from center missing for G202
E35: abscissa missing in definition of the macro
E36: ordinate missing in definition of the macro
E37: number of loops missing in definition of supercycles
E38: distance missing in definition of supercycles
E39: circle radius missing in definition of supercycles
E40: jump function not allowed in exec from peripheral
E41: call to function L (Lxx) missing or duplicated
E42: call to stored sequence (*) not defined
E43: function L not allowed in single block
E44: recall of L function in too large a file
E45: memory run out in compiling or digitizing
E46: functions not allowed between G754 and G753 (prof. invers.)
E47: points coincident or off work plane in hollow
E48: opening/closing functions missing
E49: recall of origin or corrector not valorized
E50: function G32 inside a repeated cycle
E51: nesting level of subprograms greater than 8
E52: nesting level of repeated cycles greater than 8
E53: points coincident in definition of curve by points G27
E54: incorrect subdivision of vertical profiles
E55: profile is not closed
E59: parity error or line error

E60: program read error
E62: recall of a program not existing in memory
E63: fixed cycle not executable with parameters given: S,F,J,Z
E64: fixed cycle programmed without spindle rotation M function
E65: probe not qualified
E66: stored search of a non-existing block
E67: hole start position (J) missing in def. fixed cycle
E68: cycle G88 followed by coord. other than spindle axis
E69: hollow with too many passes (> 65535)
E70: error in a geometrical definition
E71: in collision control of tool with profile
E72: too many points or entities
E73: polygonal hollow with less than three points
E74: hollows programmed with definition of tool radius
E75: straight lines are parallel, intersection missing
E76: in roughing between plane profile and section profiles
E77: intersection missing between straight line and circle
E78: hollows profiled with passes parallel to the profile
E79: management of the islands of the profiled hollows
E80: entity length too great (> 131071 mm)
E81: concentric circles
E82: external circles
E83: coincident circles
E84: tangent circles
E85: internal circles
E86: error in definition of geometric entities
E88: division by zero
E89: square root of a negative number
E90: operations between P parameters with result too great
E91: error in definition of the program parameters
E92: axes out of position
E93: axis on limit
E94: negative position not allowed
E95: invers. of traversing direction of an entity of the profile
E96: value wrong or segment missing in fly
E97: block stored by peripheral with syntax error
E98: out of limits of the operating range
E99: syntax error in the block
E200: out of limits in copying
E201: probe crash in copying
E202: loss of probe contact in copying
E206: hardware fault on digital probe
E207: digital probe disconnected
E208: hardware extra-travel on digital probe
E209: deflection of copying probe at max. limits
E210: measurement probe (on/off) crash
E211: start of measuring cycle with probe deflected
E212: copy in semispace not allowed
E213: tool reset deflection at max. limits
E253: write error on digitizing file
E254: limits opening function G877 missing in copying
E255: limits closing function G877 missing in copying
E300: locking request between axes not reset
E301: locking request between axes already locked
E400: functions not envisaged by macro

E401: macro block in wrong order
E402: insufficient internal memory to execute macro
E403: compulsory parameters missing
E404: wrong parameters in call to macro
E405: wrong profile recalled in macro
E406: tool angles not compatible with profile
E407: too many threading passes
E408: number of threading passes insufficient (min. 4)
E409: threading of a circle
E410: non monotone profile on the feed axis
E411: pass depth null or negative
E412: stock causes interference between passes
E413: max. diam. of finite profile greater than that of workpiece
E414: elements of profile not connected
E415: elements of profile intersecting
E416: throat profile wrong
E417: width of throat less than of the tool
E418: number of threading passes null or negative
E419: tool angles and orientation missing
E420: profile approach/machining direction incompatibility
E421: incompatibility between profile and parameters defined
E422: memory for shadow zone storage missing
E423: number of entities greater than allowed
E424: insufficient length of profile
E425: profiles lie on the same plane
E426: profile of the limit zone concave
E427: island outside the profile
E428: macro cannot find entities in profile
E429: definition of finite profile only with horizontal entities
E430: min. diameter of profile greater than that of raw piece
E431: bevels and joints defined simultaneously
E432: incorrect inclination of first or last entity of the throat
E433: under-cut in profile of throat
E434: circle of radius zero in profile of throat
E435: length of exit greater than length of thread
E437: tool radius without orientation
E438: tool orientation incompatible with work direction
E439: shadow zone control with wrong orientation
E440: shadow zone control with wrong tool angles
E441: tool radius different from standard values
E442: tool orientation wrong
E443: tool width missing
E444: maximum depth of tool null or negative
E445: tool width and radius incompatible
E446: extreme points of finite and raw profiles non coincident
E500: tool present both in gripper and in storage
E501: tool present both in int. st. and in storage
E502: tool present both in spindle and in storage
E503: tool position already occupied for tool..
E504: front positions insuff. for size of tool..
E505: rear positions insuff. for size of tool..
E506: size inconsistent for planar, tool..
E507: tool .. requested missing from table
E508: tool .. not enabled
E509: tool .. to be placed missing from table

E510: tool to be taken out missing from storage
E511: tool to be returned already in storage
E512: storage place missing for tool to be loaded from spindle
E513: storage place missing for loading tool from prog. T
E514: storage place missing for loading from intermediate stat.
E515: storage place missing for loading tool from gripper
E516: tool change cycle interrupted due to M.T. switch-off
E518: tool table with inconsistent data..
E519: wrong position associated with tool..
E520: manual loading of tool also present in storage
E521: tool T0 pick/place requested
E522: random-fixed loading not allowed: num.tool..
E951: error in DDI Procedure Command
E990: syntax error in file CAMME at line..
E991: wrong table number in file CAMME at line..
E992: too many values in file CAMME at line..
E993: insuff. number of values in file CAMME at line..
E1001: Gray code fault on axis absolute transducer..
E1002: signal too high analog transducer of axis..
E1003: signal too low analog transducer of axis..
E1004: position read discontinuity axis..
E1005: servomechanism error axis..
E1006: wrong number of pulses increment. transducer axis..
E1007: fault with transducer of axis..
E1008: out of tolerance positioning of axis..
E1009: contact missing between drilling head and plate
E1010: error of drilling destination plane
E1011: drilling coordinates outside work area
E1012: combination of sz commands not allowed
E1013: quik value greater than programmed safety position
E1032: spindle analog transducer signal too high
E1033: spindle analog transducer signal too low
E1034: spindle axis position reading discontinuity
E1036: spindle increment. transducer wrong number pulses
E1037: faults with spindle transducer
E1061: Gray code faults absolute transd. point-to-point axis..
E1062: transducer signal too high point-to-point axis..
E1063: transducer signal too high point-to-point axis..
E1064: point-to-point axis position reading discontinuity
E1065: servomechanism error of point-to-point axis..
E1066: wrong no. transducer pulses point-to-point axis..
E1067: faults with transducer of point-to-point axis..
E1068: secondary transd. signal too high point-to-point axis
E1069: secondary transd. signal too low point-to-point axis
E1070: faults with secondary transducer point-to-point axis
E1080: faults with potentiometric comparator..
E1108: interpol. overrun for successive block not ready
E1113: ROM memory error Inductosyn module
E1116: RAM memory error Inductosyn module
E1130: not enough time for axes of Inductosyn module
E1158: control thermocouple acquisition error
E1159: thermocouple signal interrupted control
E1160: thermocouple signal too high control
E1161: thermocouple signal too low control
E1162: faults on control thermocouple transducer

E1163: joint-cold signal too high
E1164: joint-cold signal too low
E1165: faults on joint-cold transducer
E1200: CPU master overrun: simulated work
E1202: CPU master overrun: position display
E1204: CPU master overrun: secondary sampling
E1206: CPU master overrun: primary sampling
E1208: CPU master overrun: system timer
E1210: CPU master overrun: PLC debugger
E1212: CPU master overrun: point-to-point axes
E1214: CPU master overrun: temperature controls
E1216: CPU master overrun: interpolator
E1218: MODIND overrun
E1220: fast cycles too long at PLC line..
E1222: ultra-fast cycles too long at PLC line..
E1224: too many writes in tool table
E1226: too many writes in tool table, PLC line..
E1300: malfunctioning I/O MIX..
E1302: digital expansions Watch Dog on I/O MIX..
E1304: Watch Dog on I/O MIX..
E1306: overrun on I/O MIX..
E1310: error on I/O MIX digital outputs, byte..
E1312: +24V power supply failure I/O MIX..
E1314: +24V power supply failure I/O MIX, expansion..
E1316: wait for +24V power supply I/O
E1318: encoder +5V power supply missing I/O MIX..
E1320: handwheels +15V power supply missing I/O MIX..
E1322: external +-15V power supply missing I/O MIX..
E1324: potentiometers power supply missing I/O MIX..
E1421: DDI C1D Error,drive #…, IDN000BH= …H, IDN0081H= …H
E1422: DDI C2D Error,drive #… ,IDN000CH= …H, IDN00B5H= …H
E1450: DDI error,board #…, SRCERM= …H,SRCERR=…H
E1994: access to missing component, PLC line..
E2000: stack overflow on PLC line..
E2001: CCL too large on PLC line..
E2002: too many nested CALLs on PLC line..
E2004: unbalanced RTS on PLC line..
E2006: too many nested EXEC on PLC line..
E2008: unbalanced ENDE on PLC line..
E2010: PLC not running
E2012: PLC not executable
E2014: DEF SEQCU(n) with wrong number on PLC line..
E2016: DEF SEQCU(n)=a,b, wrong (order a,b,) PLC line..
E2018: DEF SEQCU(n)=a,b, incomplete on PLC line..
E2019: a.t.c. NOT config.: impossible DEF SEQCU PLC line..
E2020: a.t.c. configured without storage places
E2021: tool life parameters inconsistent..
E2022: tool change mode wrong: SELECU=..
E2024: a.t.c. sequence not managed by PLC: NSEQCU=..
E2026: string too long in PLC line..
E2028: DISPL on non-existent line in PLC line..
E2030: CLR on non-existent line in PLC line..
E2032: non-existent string in PLC line..
E2034: variable index wrong in PLC line..
E2040: branch/set unordered condition in PLC line..

E2041: not a float.point number in PLC line..
E2042: float.point operand error in PLC line..
E2043: float.point overflow in PLC line..
E2044: float.point underflow in PLC line..
E2045: division by zero float.point in PLC line..
E2046: fpu inexact operation in PLC line..
E2047: fpu inexact decimal input in PLC line..
E2048: incorrect use of FPERMK mask in PLC
E2100: COMR of a non-existent file in robot area..
E2101: syntax error in robot area..
E2500: expression non-compilable
E2501: syntax error
E2502: operand invalid
E2503: ASCII symbol too long
E2504: operator not allowed
E2505: label not declared
E2506: recall to labels between different sections
E2507: logic line too long
E2508: reserved symbol
E2509: symbol already defined
E2510: section already defined
E2511: variables addresses not matched
E2512: symbol not defined
E2513: dimension error
E2514: too many I/O on module
E2515: PULSES out
E2516: TIMERS out
E2517: COUNTERS out
E2518: SOFTKEYS out
E2519: HARDKEYS out
E2525: too many HARDKEYS per menu
E2526: request for a non-existent HARDKEY menu
E2530: too many variables defined
E2532: code not generated
E2534: fatal error: impossible operation
E2560: expression too complex
E2562: operands inconsistent
E2563: unbalanced brackets
E2564: incorrect use of a variable
E2570: too many nested EXEC
E2571: EXEC without ENDE
E2572: ENDE without EXEC
E2580: too many numeric variables to be displayed
E2581: too many string variables to be displayed
E2590: too many digital signals to be traced
E2591: too many analog signals to be traced
E32102: M.T. switched off due to break in communication with PC
E10000: Time-out awaiting response from board **#...**
E10001: Error on RIO master,board **#...**
E10002: BINary file missing for management of board **#...**
E10004: No slave detected on RIO master,board **#...**
E10010: Malfunctioning RIO slave,board **#...** slave **#...**
E10011: RIO slave unknown,board **#...** slave **#...**
E10015: Watch-dog RIO slave,board **#...** slave **#...**
E10016: RIO reception error,board **#...** slave **#...**

E10017: RIO slave response missing,board **#...** slave **#...**
E10018: RIO output error,board **#...** slave **#...** byte **#...**
E10020: RIO 24V power supply error,board **#...** slave **#...** base
E10021: RIO 24V power supply error,board **#...** slave **#...** expansion **#...**